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AN

INQUIRY

INTO

THE NATURE AND TREATMENT

OF

DIABETES, CALCULUS,

AND OTHER

AFFECTIONS OF THE URINARY ORGANS:

WITH REMARKS

ON THE IMPORTANCE OF ATTENDING TO THE STATE OF THE
URINE IN ORGANIC DISEASES OF THE KIDNEY
AND BLADDER: AND

SOME PRACTICAL RULES

FOR DETERMINING THE NATURE OF THE DISEASE FROM THE SENSIBLE
AND CHEMICAL PROPERTIES OF THAT SECRETION.

By WILLIAM PROUT, MD. FRS.

THE SECOND EDITION,
REVISED AND MUCH ENLARGED.

LONDON:
PRINTED FOR BALDWIN, CRADOCK, AND JOY.

1825.

Med. 2.5

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PREFACE

TO THE FIRST EDITION.

THE author of the present volume has been in the habit for many years of closely attending to the Diseases of the Urine; and the following pages exhibit an outline of his observations on the subject. With his own observations, the principal facts and opinions of others have been likewise incorporated; while, on the other hand, to avoid controversy, whatever appeared doubtful has been in general omitted without remark.

It was his original intention to prefix an historical introduction respecting the urine, with a detailed account of the chemical experiments on which many of his peculiar views are founded; but upon reflection, he was induced to relinquish both these objects for the present, and to confine his attention chiefly to practical points. Chemical details could not, indeed, be altogether avoided, because chemistry constitutes the very basis on which the whole superstructure is founded; care, however, has been taken to render them as plain and concise as possible, and thus to present such a view of this part of the inquiry as may be intelligible to the general reader.

To *establish* new views on medical subjects is almost too much for an individual to hope. The author, therefore, has chiefly confined himself to *illustration;* and, leaving it to the profession at large to *establish* his conclusions (if they are capable of being established), rests in the mean time perfectly satisfied that justice will be done to his attempts.

The author's steady aim throughout his researches has been to arrive at *truth;* and whoever will direct him to this object, where he has failed to reach it, will be esteemed a friend. He never aspired to perfection; but if he has succeeded in throwing some light on the pathology of these important diseases—if he has furnished a clue by which their pathology may be still further extended—if he even convinces a single individual, that it is impossible to know any thing about the diseases of the urine, without repeated and careful examination of that secretion, he will not deem his labours altogether useless.

Southampton-street, Bloomsbury-square,
12th December, 1820.

PREFACE

TO THE SECOND EDITION.

ORGANIC diseases of the urinary organs are so frequently associated with derangements of the urine itself, that in a great variety of instances the former cannot be advantageously treated without taking into consideration the latter. Hence, with the view chiefly of offering some remarks in this part of the subject, the author has been induced in the present edition to give a summary sketch of the principal diseases of the kidney and bladder.*

In this edition also an attempt has been made to recapitulate the practical inferences deducible from the phenomena and properties of the urine. Before he made this attempt, the author was not aware of the difficulties he had to encounter; and he regrets to say, that from the utter impossibility of giving an intelligible description of many of the appearances, he has not been able to render this part of the subject so complete as he had anticipated. The author makes this avowal, lest on the one hand he should be accused of concealing what he knows; while on the other, to obviate the charge of claiming for himself a knowledge which he does not possess, he is equally anxious to state, that he has not the least pretensions to a single fact which the commonest observer may not readily learn to discriminate, *provided he will bestow the requisite attention on the subject.*

---

* For an account of the symptoms of these organic diseases (in which, of course, little of novelty could be expected), the author acknowledges his obligations to various well known treatises, and particularly to M. Sœmmering's useful little book on the diseases of the urinary organs, to which old men are more particularly liable.

Lastly, the author expresses his obligation to the President and Curators of the Royal College of Surgeons, for their liberal admission to the museum of the Royal College, to the splendid collection in which, and to the kind assistance of Mr. Clift, he is indebted for much valuable information, and particularly for many of the specimens of calculi represented in the annexed plate.

40, *Sackville-street, Piccadilly,*
May, 1825.

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ERRATA.

Page	25,	line	8,	*dele* do.
——		——	26,	*for* in short, *read* indeed.
——	27,	——	7,	*read* test for.
——		——	9,	*read* precipitate it.
——	30,	——	21,	*read* are so nearly.
——	40,	——	1,	*read* and of serum, though generally more.
——	156,	——	20,	*read* 1019·8, acid, but.
——	177,	——	14,	*read* lest it should.
——	217,	——	7,	*read* of the disease.
——	218,	——	2,	*for* expected, *read* supposed.
——	223,	——	6,	*read* but I shall.
——	245,	——	15,	*read* there are.
——	248,	——	19,	*for* than, others, *read* than others.
——		——	25,	*read* individuals.
——	249,	——	2,	*for* affection, *read* disease.
——	259,	——	2,	*read* and in some instances.
——	270,	——	16,	*read* lest the urine.
——	309,	——	30,	*read* are in some degree.
——	313,	——	17,	*read* From these symptoms.

DESCRIPTION OF THE PLATE.

In the annexed plate the author has attempted to represent the different species of urinary calculi, and at the same time to illustrate the laws of their formation, as deduced by him from very comprehensive data published by others, as well as from his own observations. See chap. v, part. I, of this volume.

Lithic Acid Series.

Fig. 1, is an exterior view of the common lithic acid calculus. From a specimen in the Museum of the Royal College of Surgeons.

Fig. 2, represents a fragment of a well defined crystalline lithic acid calculus. In this variety (abstracting the colouring matters) the lithic acid is remarkably pure. It is not a very common variety, but when it does occur, sometimes acquires very considerable magnitude, as was the case with the specimen of which this was a portion.

Fig. 3, is a section of the common compact lithic acid calculus. The centre of this calculus, though not crystalline, approaches in colour and purity to *Fig.* 2; while its exterior laminæ are much less pure, and of a paler colour, and contain, mixed with lithic acid, more or less of the lithate of ammonia and the phosphates. From a specimen in the Royal College of Surgeons.

Fig. 4, represents the common lithate of ammonia calculus. From a specimen in the Royal College of Surgeons, stated to have been taken from a girl seven years of age. See *Med. Chirurg. Trans.* vol. x. p. 389; also p. 87, of this volume.

Fig. 5, is a portion of the section of a calculus consisting internally of the lithate of ammonia, and externally principally of the triple phosphate of magnesia and ammonia. This calculus was the *second* taken from Master S. whose case is described in this volume, p. 193.

Fig. 6, is the entire section of a calculus containing, like the last, a lithate of ammonia nucleus, but surrounded by the *mixed* phosphates, or *fusible* deposite. It was taken, after death, from the bladder of a boy six years old, who had died from the irritation produced by it.

Thus the changes, which this species of calculus appears naturally to undergo in its progress towards the phosphates, are, *crystallized and nearly pure lithic acid; compact and deep-coloured lithic acid; pale and impure lithic acid; lithate of ammonia; the triple phosphate of magnesia and ammonia; and the mixed phosphates.* In the annexed plate different specimens have been chosen to illustrate this series; but it is to be observed, that the same specimen sometimes contains several, or even all, the varieties; while, in others, many of the varieties are often altogether wanting. The above order also, from particular circumstances, is in some cases liable to be more or less inverted, though the author has never seen an instance in which it *has been completely inverted;* that is to say, *in which the phosphates have constituted the centre, and the lithic acid the exterior of the calculus.* The knowledge of this law in a practical point of view is of the utmost importance; for as we can always tell very nearly by an examination of the urine, what particular deposite prevails in it at any given time, we are thus enabled to form an opinion, not only as to what *has,* but what *will* very probably happen to our patient.

Oxalate of Lime. Series.

Fig. 7, is an exterior view of the oxalate of lime or mulberry calculus. From a specimen in the Royal College of Surgeons.

Fig. 8, represents an internal view of the same species of calculus. From a specimen in the Royal College of Surgeons.

Fig. 9, is the section of a calculus, showing the alternation of the lithic acid and mulberry deposites. In the centre is a nucleus consisting principally of the lithic acid. Exteriorly to this is the mulberry deposite; and to this again succeeds the lithic acid, which constitutes the whole external crust. From a specimen taken from the kidney after death, and for which the author is indebted to Dr. Elliotson.

Fig. 10, is from a specimen in the Royal College of Surgeons. In the centre is the lithic acid; then follows the mulberry, while exterior to the whole are the mixed phosphates.

Fig. 11, is an *external* view of the calculus composed of the mixed phosphates, or the *fusible* calculus. From the Museum of the Royal College of Surgeons.

From this series we see that the lithic acid and the mulberry deposites alternate with one another, which, as far as we know at present, is peculiar to these two species of calculus. The phosphates here, however, as in the lithic acid series, are always *external*, or at least so very rarely constitute the centre of the mulberry calculus, that no instance of this circumstance has yet occurred to the observation of the author.

Cystic Oxide and Phosphate of Lime Calculi.

Fig. 12, is an external view of the cystic oxide calculus. From Dr. Marcet's work on Calculous Disorders.

Fig. 13, is a section of another specimen of this rare species of deposite in the author's possession, and for which he is indebted to Dr. Henry of Manchester.

The author has seen no specimen of this species of calculus surrounded by the phosphates; though an instance of this has been noticed by Dr. Wollaston, its discoverer.

Fig. 14, are specimens of the small rough variety of prostatal concretion, which usually occurs in that gland before any extensive disorganization has taken place.

Fig. 15, 16, and 17, represent specimens of the porcelainous variety of prostatal concretion, occuring in abscesses of that organ. *Fig.* 15, is an external view. *Fig.* 16, represents a section, and showing the radiating striæ peculiar to the phosphate of lime concretion. *Fig.* 17, is a fragment, somewhat resembling a piece of bone or shell. These specimens were extracted by Mr. Brodie from the gentleman whose case is mentioned in this volume, p. 237.

It is to be observed, that in the above description the author does not take into account those thin white films which frequently exist between the different laminæ of calculi, and which (except in a particular point of view only) have nothing to do with their general formation.

INTRODUCTION.

Composition, &c. of the Urine.—General Remarks on Urinary Derangements.—Division of the Subject.

In order to exhibit the peculiarities of the urine, and the morbid conditions to which it is liable, in a more striking point of view, I purpose, in the following sketch, to consider the various principles which enter into its composition, with reference to those entering into the composition of the blood from which it is formed. Hence it will be necessary to premise a summary description of these two fluids.

Blood is that well-known red fluid existing in certain vessels (hence denominated blood-vessels), from which all animal products are formed. Its consistence is somewhat thick, and it has a saponaceous feel. Its taste is slightly saline, and its odour peculiar, and more or less strong in different animals. Its specific gravity varies in the same animal at different times; but, generally speaking, the specific gravity of human blood may be said to be between

1·030 and 1·055. Though blood, as it circulates through the body, seems to be a homogeneous fluid, it appears under the microscope to be heterogeneous, and presents the appearance of *solid red particles*, of a globular figure, diffused through a colourless liquid. Blood, when removed from the body, in a very short time spontaneously undergoes a remarkable change, termed coagulation. By this process it is separated into a fluid of a yellowish colour and slight tenacity, called the *serum*, and into a coagulum, more or less firm, of a dark red colour, called the clot, or crassamentum. By a further examination it is found that this clot consists of a mixture or compound of two principles—the *solid red particles* above-mentioned, and a white elastic fibrous matter termed *fibrin.**

On exposing the fluid, or serous portion of the blood, to the temperature of about 160°, it also becomes a white opaque solid, like the *albumen ovi* similarly treated, and having similar properties. It is not, however, pure *albumen;* for if it be cut into pieces, and placed in a funnel, we shall find, after some hours, a small quantity of fluid ooze from it, which is incapable of undergoing coagulation by heat, and possesses other peculiar properties. This fluid, which is termed the *serosity,* may also be obtained by boiling or well washing the coagulated serum in water. Various opinions have been maintained by different chemists respecting the nature and composition of this portion of the blood; but it is admitted, I believe, by all, to consist of various salts, and some peculiar animal matters. The most recent opinion on the subject is that of Berzelius, who states it to consist of soda holding albumen in solution, of muriates of soda and potash, of lactate of soda, and of a peculiar animal matter which always accompanies the lactates.

---

* According to the recent observations of Mr. Bauer, the *fibrin*, or *coagulable lymph,* as it is frequently termed, originally exists in the blood in the state of very minute *white globules.*—Philos. Trans. 1820, p. 1.

Blood then appears to consist of

Water,
Solid red particles,
Fibrin,
Albumen,
From the similarity of their chemical properties, termed by Berzelius, the *albuminous principles* of the blood.
Lactate of soda, and some peculiar animal matters, which, according to Berzelius, always accompany it.
Muriates of potash and soda.

All of which, except the red particles, and perhaps the fibrin, are held in a state of solution whilst circulating in the living body.

The red particles of the blood, when burnt, yield iron, and a small proportion of the earthy phosphates. Albumen and fibrin, when burnt, yield traces of the sulphates and phosphates, but none of iron. Now albumen is known to contain a small proportion of sulphur in some unknown state of combination; and Berzelius thinks, with great reason, that the sulphates, phosphates, and oxide of iron, obtained by incinerating albumen, fibrin, and red particles of the blood, existed originally in these principles in the states of sulphur, phosphorus, calcium, and iron.

The specific gravity of serum has been stated to be at a mean about 1·028. Dr. Marcet makes it a little higher, or 1·0295. The specific gravity of fibrin appears to be somewhat less, since it usually swims in the serum; whilst that of the red particles is greater, as appears from their sinking in that fluid.

The proportion of these ingredients to one another seems to vary considerably, at different times, in the blood of the same person. The most usual proportion of the crassamentum to the serum is about 1 to 3. Haller fixed the extremes at 1 to 1, and 1 to 4. The proportion of the colouring matter to the fibrin, Berzelius found in one instance to be as 1·8 to 1; but the proportion is evidently very variable.

Healthy human urine, when recently voided and still warm, is a transparent fluid of a light amber colour. At this time its odour is aromatic, and somewhat resembles that of violets; but the taste is bitter and disagreeable. As it cools, the aromatic smell leaves it, and gradually gives place to another, which is peculiar, and well known by the name of *urinous*. In a few days, this is succeeded by another, which has been compared to that of sour milk. At length this also gradually disappears, and is finally succeeded by a fœtid alkaline odour.

Healthy urine, when first voided, reddens litmus paper; and has, therefore, been generally considered as containing a free acid. Its mean specific gravity has been estimated to be between 1·010 and 1·015. It is one of the most heterogeneous fluids known, as the following results of an elaborate analysis by Berzelius will show. 1000 parts of healthy human urine consist of

	Water	933·00
Animal and destructible principles.	Urea	30·10
	Lithic acid	1·00
	Pure lactic acid, lactate of ammonia, and animal matters not separable from these	17·14
	Mucus of the bladder	·32
Alkaline and earthy salts.	Sulphate of potash	3·71
	——— of soda	3·16
	Phosphate of soda	2·94
	——— of ammonia	1·65
	Muriate of soda	4·45
	——— of ammonia	1·50
	Earthy phosphates, with a trace of fluate of lime	1·00
	Silex	·03
		1000·00

Besides these ingredients, which appear to be essential to *healthy* urine, this secretion in different *diseases* has been found to contain albumen, fibrin, and the red particles of the chyle and blood; nitric acid, various acids formed from the lithic, oxalic acid, benzoic acid, and carbonic acid; xanthic oxide, cystic oxide, Prussian blue? sugar, bile, and pus. Perhaps what we have said on the composition of these two fluids will be rendered more striking by the following contrasted tabular view of their constituent principles:

Blood contains	Urine contains, *Healthy,*	*Diseased,*
Water.	Water.	———
Albumen, fibrin, red particles.	——— ———	Albumen. Fibrin. Red particles.
———	Urea.	———
———	Lithic acid.	———
———	———	Nitric acid. Erythric acid. Purpuric acid. Melanic acid? Oxalic acid. Benzoic acid. Carbonic acid. Also xanthic oxide. Cystic oxide. Prussian blue? Sugar. Bile.
Lactic acid, and its accompanying animal matters.	Lactic acid, and its accompanying animal matters.	———
Sulphur. Phosphorus. Muriatic acid. Fluorine?	Sulphuric acid. Phosphoric acid. Muriatic acid. Fluoric acid?	———
Potash. Soda. Lime. Magnesia. Silex?	Potash. Soda. Ammonia. Lime. Magnesia. Silex?	———
———	Mucus of the bladder.	———
———	———	Pus.

1. *Water* forms the basis of the blood and urine, as well as of all animal fluids. When its quantity, however, is raised or depressed above or below a certain standard, it becomes a source of disease, especially in the urine. Thus there is sometimes a simple increase of the watery portion of the urine, while the other principles remain the same, or become much diminished; as in hysteria and various nervous affections. Sometimes the increased flow of urine is accompanied by an increased proportion of a natural ingredi[illegible] or of unnatural ingredients, as

of albumen or sugar. On the other hand, the proportion of water in the urine is not unfrequently very much diminished below the natural standard, as in the various forms of urinary suppression. Sometimes, when the cause of this suppression is mechanical, the urine is simply diminished in quantity, while its composition and qualities remain the same: at other times the suppression is connected with deranged action of the kidneys; and in these cases, while the porportion of water is diminished, those of the other ingredients are relatively much increased, as happens in various forms of gravel and calculus. *Watery* urine is usually limpid and colourless, and may be readily known by its low specific gravity, and the unnatural quantity in which it is voided.

2. *Albumen, fibrin, and the red particles,* which constitute the great bulk of the matters existing in the blood, are never met with in healthy urine; but in some varieties of dropsy, and other diseases, the urine not only contains the serum of the blood, but the fibrin and red particles likewise pass through the kidneys unchanged. It may, however, be observed, that the albuminous matters found in the urine are usually more analogous to those of the chyle than of the blood, as will be shown hereafter. In the latter case, the urine is commonly of a pale colour, and more or less opaque.

Urine containing blood derived from any other source than the kidneys, is, of course, likewise *albuminous.*

Albuminous urine, on being exposed to a temperature of about 150°, becomes opaque, and deposites this principle in a coagulated state. The precipitate varies considerably in its appearance in different instances. Sometimes it is of a firmer character, and similar to that formed by the serum of the blood, from which, in this case, it may be supposed to be derived; at other times it is very delicate and fragile in its texture, and somewhat resembles curd, when it may be supposed to be of chylous origin. In some instances, the effects of heat upon albuminous urine are increased by the addition of nitric acid. But the most delicate test of albuminous matter in general is dilute acetic acid, and the prussiate of potash.

3. *Urea.* This principle is peculiar to the urine, and is formed by the action of the kidney from some of the constituents of the blood, perhaps the albumen.[*] The colour and other sensible qualities of the urine were formerly ascribed to this principle; but Berzelius showed, many years ago, that urea was colourless;[†] and in 1817, a paper was published by me,[‡] in which it was shown that this principle is not only colourless, but has no remarkable smell nor taste. The following is a summary account of its properties:

---

[*] An attempt has been lately made to show that urea is found in the blood when the kidney is removed. Bulletin des Sciences par la Société Philomatique, &c. Juin, 1822.

[†] View of the Progress and Present State of Animal Chemistry, p. 101.

[‡] Med. Chirurg. Transactions, viii. p. 529.

"Urea most commonly assumes the form of a four-sided prism. Its crystals are transparent and colourless, and have a slight pearly lustre. It leaves a sensation of coldness on the tongue, like nitre. Its smell is faint and peculiar, *but not urinous.* It is neither sensibly acid nor alkaline. It undergoes no apparent change on exposure to the air, except in very damp weather, when it slightly deliquesces, but does not seem to be decomposed. Exposed to a strong heat, it melts, and is partly decomposed, and partly sublimes, apparently unaltered. The specific gravity of its crystals is about 1·350.

"Water at 60° dissolves more than its own weight of urea; and the solution exposed to the air for several months underwent no change.* Boiling water dissolves any quantity of it whatever, and the urea does not appear to suffer any change at this temperature. Alcohol (specific gravity ·816), at a mean temperature, dissolves about 20 per cent.; and, at a boiling temperature, more than its own weight; and the urea separates, on cooling, in a crystallized form. It is very sparingly, if at all, soluble in sulphuric ether, or the essential oil of turpentine, though these fluids are rendered opaque by it.

"The pure fixed alkalies and alkaline earths decompose it when heat is applied and water present. The result is chiefly carbonate of ammonia. It unites with most of the metallic oxides. Its combination with the oxide of silver is greyish, and detonates on being heated, and the oxide is reduced. It does not seem, however, to be alone capable of decomposing any metallic salt; but in order to effect the union, the aid of double affinity is necessary. It combines with nitric acid, and forms a crystallized compound, but sparingly soluble in water, and which has been long known to chemists. It forms also a similar compound with oxalic acid. In neither of these compounds are the acids neutralized."

---

* When the solution contains the least impurity, the urea is speedily decomposed, and converted into the carbonate of ammonia; this has been long known, but the fact has been lately more precisely determined by Vauquelin. Annales de Chimie et de Physique, xxv. 423.

An excess of urea in the urine seems to be characteristic of a peculiar form of disease, to be described hereafter. The mode which I commonly use to detect an excess, is to put a little of the urine into a watch-glass, and add to it carefully nearly an equal quantity of pure nitric acid, in such a manner that the acid shall subside to the lower part of the glass, from its greater specific gravity, and allow the urine to float above it. If spontaneous crystallization takes place, an excess of urea is indicated; and the degree of excess can be inferred, near enough for practical purposes, by the greater or less time which elapses before the crystallization takes place, which time may vary from a few minutes to two or three hours. Such urine is commonly, but not always, of a pale colour.

I know of no disease characterized by a diminished proportion of urea. It is true, that in diabetes, and some other diseases of the urine, very little urea is sometimes present; but the same holds with respect to the other principles, many of which are deficient in such urine as well as urea. Hence the absence of urea can scarcely be considered as characteristic. It has been said, also, that in hepatitis this principle is deficient; but this by no means accords with my experience. In fact, I am disposed to assert that generally in this disease there is an excess of urea in the urine, rather than a deficiency.

4. *Lithic acid.* Lithic, or uric acid, is not found in the blood; but it appears to be a constant constituent of healthy urine, in which fluid it exists in a state of solution at all ordinary temperatures. In a pathological point of view, this acid is, perhaps, of more importance than any other. I shall therefore enter rather minutely into its history under the two following heads: *a.* Its mode of existence in healthy urine; *b.* The modifications which it is capable of undergoing.

a. It has been before stated, that fresh human urine reddens litmus paper, and that in consequence it has been supposed to contain a free acid. In inquiring into the cause of this acidity, Berzelius remarks, "as by the laws of chemical affinity the acids of the urine will unite with any alkali that may be present, and saturate themselves with it in the order of the force of their respective affinities, it must follow, that when the quantity of alkali is insufficient to saturate all the acids present, the weakest acids must be those that will remain uncombined and will give the urine its acid properties. These, therefore, must be the *lactic* and the *uric*." *

Thus it appears to be the opinion of this eminent chemist, that the lithic acid exists in the urine, at least in part, in a free state, and, consequently, that it is held in solution merely in virtue of its solubility in water: and this I believe is the general opinion upon the subject. On reflecting upon this opinion, however, it seemed to me very improbable, for the following reasons:—First. According to the analysis of Berzelius, 1000 parts of healthy urine contain in solution one part of lithic acid; but Dr. Henry states, that one part of lithic acid requires, at 60°, at least 1720 parts of water to dissolve it. Now, how are we to reconcile these two statements, on the supposition that lithic acid exists in the urine in a free state? Secondly. The addition of any acid to the urine, even the carbonic, as is well known, throws down the lithic acid. How is it possible to explain this fact, except on the supposition that the new acid combines with something retaining the lithic acid in solution, which, being set at liberty, is thus incapable of remaining any longer in solution, and is consequently precipitated in the solid form. Thirdly. There is no instance known in which lithic acid is secreted in a free state: birds, serpents, &c. always secrete it in combination with ammonia; in the gouty chalk-stone it is secreted in combination with soda.

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* Med. Chirurg. Trans. iii. p. 257.

To suppose, therefore, that the human kidney secretes lithic acid in a free state, is to suppose an exception to a law which appears to be very general. Lastly. The lithate of ammonia often *does* exist in large proportions in human urine, as is proved by the fact that many of the amorphous sediments consist chiefly of that compound, as will be shown hereafter. On reflecting upon these circumstances, I was induced to make some experiments on the subject, the result of which has been such as to render it probable that the lithic acid in healthy urine exists in a state of combination with ammonia, and that in reality this fluid contains no uncombined acid at all.

Thus, with respect to the solubility of lithic acid in water, I find that this principle, when pure, requires about six times more water to dissolve it than has been stated by Dr. Henry, or at least 10,000 times its own weight at 60°; a fact which adds much to the improbability of the common opinion. On the contrary, the lithate of ammonia requires only about 480 times its weight at the same temperature; and if to the solution any acid be added, the lithate is immediately decomposed, and the acid precipitated in the solid state; just as happens to the urine when similarly treated. Further, the lithate of ammonia, when in solution, reddens litmus paper; and what is singular, and scarcely would have been expected, is likewise capable of existing in the same solution with a solution of the super-phosphate of ammonia, which, as is well known, has likewise the property of reddening litmus paper. Now, as the phosphate, or rather super-phosphate of ammonia exists in healthy urine, this fact, taken in conjunction with the others, enables us to account very satisfactorily for the two important points in question, namely, the property of reddening litmus paper possessed by that fluid, and also for the permanent state of solution in which the lithic acid is held in it; both of which appear inexplicable on the common opinion. Further, if we evaporate healthy urine slowly, as, for example, under the receiver of an air-pump, with sulphuric acid, the lithate of ammonia is deposited on the sides of the vessel in abundance, in the form of an amorphous sediment; whereas, if this acid existed in the urine in the free state, it should be deposited in a pure crystallized form. Lastly, the supposition that the lithic acid exists in the urine in the state of lithate of ammonia, will enable us to throw considerable light on the phenomena presented by the urine in different diseases, as will be shown hereafter.

b. On the changes which lithic acid is capable of undergoing.—1. When nitric acid, diluted with about an equal bulk of water, is poured upon pure lithic acid, and a moderate heat is applied, an effervescence takes place, and the lithic acid is dissolved. If we concentrate this solution by a gentle evaporation, we obtain transparent colourless crystals, which have been found to constitute a peculiar acid, and have been hence named by M. Brugnatelli, who first described them, *erythric acid.*[*] 2. If into a strong solution of these crystals in water, whilst boiling hot, we carefully drop pure ammonia, the solution acquires a beautiful purple colour, and crystals of *purpurate of ammonia* speedily begin to form and subside. 3. If these crystals are treated by means of potash and sulphuric acid, in a manner formerly described by me,[†] pure *purpuric acid* is obtained in the form of a yellowish or cream-coloured powder. Such is a part of the series of changes which lithic acid is capable of undergoing, and apparently does undergo, in the human body in different diseases, either by the action of the kidney, or the natural operation of the various principles existing in the urine upon one another, as we shall now attempt to explain.[‡]

The amorphous, or uncrystallized sediments, usually denominated *pink* and *lateritious* sediments, and supposed by Proust to constitute a peculiar acid, which he named the *rosacic*, have been long known.

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[*] Giornale di Fisica, 1818. [†] Philos. Trans. 1818, p. 420.

[‡] Another principle apparently connected with lithic acid has been found in one instance by Dr. Marcet, in a specimen of *black* urine, and for which, from its properties, the term *melanic* acid has been proposed. See Med. Chirurg. Trans. xii. 37. Instances of *black* urine have been frequently alluded to by authors, and indeed a condition of the urine which would be *vulgarly* considered as *black* is not very uncommon. But the modification of disease described by Dr. Marcet, in the above paper, is, I am satisfied, exceedingly rare, and I doubt if it had been ever before noticed; certainly not at least in a way to render it easily recognized.

These I find, by well-known methods, to consist essentially of the *lithate of ammonia,* and sometimes of the *lithate of soda.* They owe their colour partly to the colouring matter of the urine, to be described hereafter, and partly (in some instances apparently almost entirely) to the *purpurates of the same bases.* I acknowledge that it is difficult, or indeed almost impossible, to prove these latter points by direct experiment; but the following observations will, I think, place their truth beyond a doubt.

When pure lithate of ammonia is diffused through fresh healthy urine, it attracts to itself a portion of the colouring matter of that fluid, and falls down in the state of a yellowish powder. But if the least quantity of a solution of an alkaline purpurate be added to the urine, such is the affinity of the lithate of ammonia for this colouring substance, that it immediately attracts the purpurate to itself, and assumes the form of a red or pink powder, more or less deep, and varying in tint according to the purpurate employed. From these observations it is evident that, if ever the purpurates exist in the urine when amorphous sediments are precipitated from it, these sediments must necessarily become more or less tinged by them. To establish the point in question, therefore, we have now only to render it probable that the purpurates do exist in the urine under certain circumstances of disease.

I have shown elsewhere,[*] that the pink and lateritious sediments occasionally contain nitric acid in some peculiar state of combination. Now the purpuric acid, or rather the purpurate of ammonia, is only lithic acid modified by the action of the nitric acid. If, therefore, nitric acid and lithic acid exist in the urine together, it is exceedingly probable, or rather certain, that at the temperature of the human body, a portion of the lithic acid will be acted on by the nitric acid, and converted into *purpurate of ammonia.* These facts, then, especially when taken into account with the absolute identity of tint, are, I think, sufficient to convince every unprejudiced reader that the pink amorphous sediments owe their colour chiefly to the alkaline purpurates, though from the circumstance of their being merely as it were dyed with the purpurates, these cannot be separated, and thus actually be demonstrated to be present.

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[*] Med. Chirurg. Trans. ix. p. 481.

In some forms of disease the urine does really contain an uncombined acid, as will be presently shown; and in this case the lithate of ammonia is decomposed, and the lithic acid deposited in a crystallized form, and nearly pure; thus constituting the disease called *gravel.*

The lithic acid and its compounds may be easily detected by the above singular properties. When they exist abundantly in the urine, this fluid is almost invariably of a deep colour; and if at the same time a free acid be present, the urine is for the most part unusually transparent, and free from mucus.

8. *Oxalic acid.* This acid is neither found in the

blood nor in healthy urine. It is secreted in some forms of disease; but whether in a free state is not known, as it always occurs in combination with lime, which, from its great affinity for that earth, it may be supposed to get from the urine. The *oxalate of lime*, in some rare instances, appears as gravel, sometimes as an amorphous sediment, and not unfrequently forms calculi. When burnt, it yields quick-lime; or if boiled with an excess of sulphuric acid, the oxalic acid may be obtained in a separate state, and thus be readily distinguished by its properties.

9. *Benzoic acid.* This acid does not exist in the blood nor in healthy human urine. It has been stated by Scheele to exist occasionally in the urine of children; but this is doubted by Berzelius, and I think with great reason, as I have never myself met with an instance of its occurrence. Proust informs us that this acid may be obtained from the urine in which it exists by concentration. It may be easily recognized by its proneness to assume the crystallized form and by its volatility, properties not possessed in common by any elementary principle existing in the urine.

10. *Carbonic acid.* This acid has been stated by Mr. Brande to exist in the human urine; but the opinion was called in question by Berzelius. Some experiments, however, of Dr. Marcet, render it probable that under certain circumstances carbonic acid really exists in this fluid; * and I have myself seen small calculi discharged from the bladder composed

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* Essay on Calculous Disorders, p. 159, first ed.

principally of the carbonate of lime. The existence of this acid in the urine may be shown by placing it under the receiver of an air-pump, with lime-water, in the manner described by Dr. Marcet.

11. *Xanthic oxide.* This name has been given by Dr. Marcet to a substance constituting the chief bulk of a small renal calculus. It does not exist in the blood, and has never, as far as I know, been observed in the urine but in one instance, and consequently must be extremely rare. It seems to be nearly allied to lithic acid. It derives its name from its property of yielding a lemon *yellow* colour when treated with nitric acid, a property by which it may be distinguished.*

12. *Cystic oxide.* This substance is peculiar to the urine, and sometimes forms entire calculi. Such calculi are rare. Cystic oxide may be distinguished by its solubility in alkalies, and most acids, and by the characteristic odour it yields when burnt. It is however very little soluble in acetic acid, hence when it exists in the urine it may be readily precipitated from that fluid by vinegar.

13. *Sugar.* This principle is not found in the blood even of individuals labouring under diabetes, in whose urine it exists in the greatest abundance; it is not a constituent of healthy human urine, nor, what is curious, has it to my knowledge ever been

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* A substance supposed to be *prussian blue* has been in some rare instances met with in the urine. See N. Act. Nat. Cur. viii. Obs. 21; also Archives Gen. Mai, 1823.

found in the urine of any other animal. The sugar of diabetic urine differs in its appearance from common sugar, and approaches more nearly to the sugar of grapes. A large quantity of sugar may, for the most part, be readily discovered by the sweet taste which it imparts to that fluid; but when in small quantity, its presence is with difficulty detected. Urine containing sugar, is generally pale coloured, has a specific gravity above 1.030, and its natural ingredients are much diminished in quantity.

14. *Bile.* In certain diseases, and particularly jaundice, this fluid seems to find its way into the urine in small proportions. Such urine is generally of a deep brownish red colour when in considerable quantity, and viewed by transmitted light; but when examined in small quantity, it has sometimes a greenish appearance. A piece of white linen is well known to be stained yellow by such urine; and the addition of muriatic acid renders it green. Of the two, the latter appears to be the most unequivocal test, when it produces its proper effects, though these will sometimes not occur for several hours, or even days, and sometimes not at all.

15. *Lactic acid, and its accompanying animal matters.* These principles, according to Berzelius, exist both in the blood and the urine; thus passing through the kidney without undergoing any change. According to this eminent chemist, also, it is chiefly to these principles that the urine owes its sensible qualities of smell and colour; and he ascribes like-

wise principally to the presence of pure lactic acid its property of reddening litmus paper, as before stated. I would not be understood to deny either of these points; but I confess I have never been able to satisfy myself of them so completely as I could wish. We have seen above, that the property of reddening litmus paper possessed by the urine, may be accounted for on other principles; and as to the colour of the urine, I have stated that this appears to be sometimes owing, in part at least, to the presence of the purpurates. I admit, however, the existence of a colouring principle in the urine, besides the purpurates: but, as far as I know, it has never been obtained in a separate state.* The colour of the urine is liable to be modified by the nature of the ingesta, and a variety of other circumstances.

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* I have sometimes thought that a great many of the phenomena presented by the colouring principle of the urine cannot be explained, except on the supposition that it is of two distinct kinds. Thus, if we add pure lithate of ammonia to healthy urine, we find that it invariably acquires a certain colour, more or less deep, and precisely of the usual tint of lithic acid calculi. If we perform this process repeatedly, by adding fresh portions of the lithate of ammonia to the same urine, we find that the lithate of ammonia is rendered paler and paler every time, and at length ceases to acquire colour; yet, what is singular, that the apparent colour of the urine is very little different from what it was at first. Now, how are we to explain this circumstance, except upon the supposition that there are at least two species of colouring matter in the urine; one of which has an affinity for the lithate of ammonia, and the other none at all? It is to the first of these species of colouring matters that lithic acid calculi appear chiefly to owe their colour; and the tint is very peculiar and characteristic. The other species of colouring matter appears to be ill defined, and of uncertain composition: yet both of them are evidently somehow or other connected with lithic

The cause of the peculiar *smell* of the urine has never been explained; but it is probably connected with some undefinable compound into which, if I am not mistaken, sulphur, phosphorus, and azote, largely enter. The smell of the urine also, as is well known, is liable to be much affected by various articles taken into the stomach, as asparagus, turpentine, &c.

16. *Sulphur. Sulphuric acid. Sulphates.* Sulphur exists in the blood in minute quantity, apparently as a constituent of its albuminous principles; but sulphuric acid is not met with in that fluid. Sulphur also appears to exist in some peculiar state of combination in the urine; but by far the greatest proportion of this principle exists in the urine as sulphuric acid, in combination, of course, with the alkaline matter present. I do not find that sulphuric acid has ever been suspected of being concerned in the production of any morbid condition of the urine; and I believe it never has been observed to form (in combination with lime, for instance) any sensible

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acid, as they soon disappear after that principle becomes deficient in the urine, as in diabetes, when the phosphates are deposited in excess, &c. in which diseases the urine is invariably of a pale colour. Hence it is not improbable that these different colouring matters are intimately connected with one another, as well as with lithic acid.

Brugnatelli has made some remarks on the colouring matters of the urine; but they are very little to the purpose. Giornale di Fisica, i. p. 132.

proportion of urinary calculi or gravel. This would seem to show that variations in the quantity of this principle are more limited than those of some other principles found in the urine, which is probably the case. I think, however, that I have seen a case where the sulphuric acid, in a free state, acted remotely as a precipitant of the lithic acid. The gentleman in whom this occurred was corpulent, and subject to eructations, which he compared to *bilge water*, and which probably contained sulphuretted hydrogen. The presence of sulphuric acid in the urine may be shown by its yielding a precipitate insoluble in nitric acid, on the addition of the nitrate of barytes.

17. *Phosphorus. Phosphoric acid. Phosphates.* Phosphorus, like sulphur, appears to exist in minute quantity both in the blood and urine; and probably, like that substance also, as an element of some of the constituent principles of these fluids. Phosphoric acid exists in the blood in very minute quantity, if at all; but in healthy urine it is met with, according to the best analysis, in about the same proportion as sulphuric acid. In a pathological point of view, phosphorus and its compounds particularly claim our attention. I am not acquainted with any disease connected with the simple absence of phosphorus and its compounds from the urine; though the existence of such a disease is not improbable, when we consider that health is always accompanied by the due separation of a certain proportion of these principles from the economy. On the contrary, cases where this

acid and its compounds exist in the urine in excess, are by no means uncommon.* Phosphoric acid, however, becomes most formidable when the earthy bases, lime, and magnesia, are secreted in greater abundance than natural; which, by combining with the acid, form insoluble phosphates, and thus constitute by far the most distressing species of gravel and calculus. In healthy urine this acid, like the sulphuric, appears to exist principally in union with potash, soda, and ammonia, and partly, perhaps, with lime and magnesia; the different salts being, from the excess of acid, in the state of superphosphates. Phosphoric acid is shown to exist in the urine by its yielding, with the nitrate of barytes, a precipitate soluble in nitric acid, and again precipitable from that acid, by ammonia, without decomposition.

18. *Muriatic acid. Muriates.* The muriatic acid, in combination with soda and potash, occurs both in the blood and in the urine; thus appearing to pass through the kidneys unchanged. This acid and its compounds formerly appeared to be of less importance in a pathological point of view than any other similar principles existing in the urine; but since the unexpected fact has been ascertained, that muriatic acid in a free state exists abundantly in the stomachs of animals during the process of diges-

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[*] Instances are on record, where the urine has contained so much phosphorus as to render objects dipped in it luminous in the dark. See Ephem. Nat. Cur. Dec. I. Ann. vi. & vii. Obs. 193. also Ann. de Chimie, Fev. 1814.

tion,* I have attended a little more closely to the appearance of this principle in the urine, and am disposed to believe, in consequence, that it is the cause of the precipitation of lithic acid gravel from the urine more frequently than any other acid. I do not mean to say, that it is the *immediate* cause of the precipitation of this acid, for in most instances it acts like all powerful acids do under similar circumstances, namely, by liberating the weaker acids, which are thus enabled to act in their turn, and separate those having still weaker affinities than themselves. Thus, in the present instance, the muriatic acid may be supposed to separate the lactic, while the latter precipitates the lithic, &c. If this opinion be well founded, as I believe is the case, the muriatic acid may be considered as of very great importance, not only in a pathological but a physiological point of view; for if the muriatic acid found in the urine in such instances be supposed to have its origin in the digestive organs, we see at once the reason why the deposition of gravel is so liable to be influenced by the derangements in general, and more especially by the acidity, of the stomach. Another circumstance of a negative character indeed, connected with the present subject, seems to corroborate this opinion. In several cases (in short, in every one in which I have made the experiment) I have found the quantity of muriatic acid exceedingly diminished, and sometimes even almost entirely wanting, in the urine of persons at the point of death. Now though this circumstance was unquestionably to be referred in part to the diminished quantity of muriate of soda taken for some time previously by the individuals in these cases, there can be no doubt, that it depended in a much greater degree upon the total inactivity or annihilation of the functions of the stomach. The muriatic acid may be shown to exist in the urine by the white curdy precipitate insoluble in nitric acid, which is formed when the nitrate of silver is added to it, after the sulphuric and phosphoric acids have been removed by the nitrate of barytes or lead.

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* See Philos. Trans. 1824.

19. *Fluoric acid* is said by Berzelius to exist in the urine in small quantity, combined with lime; but, as far as I know, this observation has not been verified by any other chemist. It may be detected by its property of corroding glass.

20. *Soda. Potash. Ammonia.* The two fixed alkalies, as before stated, exist both in the blood and the urine, in union with the sulphuric, phosphoric, muriatic, and, according to Berzelius, the lactic acids. Ammonia exists only in the urine, apparently in combination with the muriatic, phosphoric, and lithic acids. No disease is known to arise from the excess or defect of the fixed alkalies; but the deposition of the earthy phosphates in the urine is almost always accompanied, if not immediately produced, by an excess of ammonia. Hence, in a pathological point of view, this is a principle of the greatest importance. Sometimes, however,

ammonia exists in the urine in great abundance in the free state, when the phosphates are not in excess, but even less than usual. The most frequent source of the excess of ammonia is the urea, as will be more particularly pointed out in the next paragraph. The alkaline salts may be obtained from the urine by evaporating it to dryness. There is no test fo soda; but its salts may be recognized by their form Potash may be known by the insoluble precipitate t forms with the muriate of platinum; and ammonia by its volatility, and peculiar odour.

21. *Lime. Magnesia. Silex.* Lime and magnesia exist both in the blood and the urine; but in very different states. In the blood they appear to enter, perhaps as elements, into the composition of the albuminous principles; and hence cannot be obtained without combustion: in the urine they occur chiefly in the saline state, apparently, as before observed, in union with the phosphoric acid. I am not acquainted with any disease characterized by a deficiency of these earths in the urine; but the most distressing and dangerous form of calculous complaints is connected with, and, indeed, immediately arises from, their *excess*, namely, the deposition of the earthy phosphates. In this form of the disease, the earthy bases seem to be separated in a much greater proportion than usual; while the quantity of phosphoric acid is relatively diminished. This deficiency of phosphoric acid, however, does not seem to arise from a deficiency of phosphorus, but from some de-

fect in the oxygenating operation of the kidneys, by which that principle is permitted to pass through them unchanged: for the urine under these circumstances often seems to contain, in some unknown state of combination, even more phosphorus than natural. The urea, also, in this form of disease, exists in great abundance, but in some peculiar and apparently imperfect state, by which it is rendered extremely prone to decomposition, and liable to be converted into the carbonate of ammonia.* Hence the urine in this disease is either naturally alkaline, or speedily becomes so; and this excess of alkali contributes to the union of the earthy bases with the phosphoric acid present, and their consequent deposition in the form of phosphates. Urine containing an excess of the phosphates, is generally of a pale colour.

The phosphates of lime and magnesia may be precipitated from the urine by ammonia: the phosphate of lime usually appears in the state of an amorphous powder; the phosphate of magnesia, which combines with the ammonia, and thus forms a triple phosphate of magnesia and ammonia, in the form of minute crystals.

Silex has been stated to constitute urinary sediments, and even to form a part of urinary calculi in some instances: but this assertion requires to be better authenticated than it is at present, before it can deserve credit. This earth, however, ordinarily exists in the urine in minute quantity, according to Berzelius; but he supposes it to be derived from the water which we drink, which is not improbable. It may be readily distinguished by its insolubility in all acids except the fluoric, and by its other well-known refractory properties.

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* The fixed alkali in combination with the mucus commonly present on these occasions in great abundance, seems to be a chief cause of the decomposition of the urea.

Besides these there are two other principles met with in the urine, namely, *mucus* and *pus*, which, although not products of the kidneys, require, from their great importance, to be considered here; and, first, of

22. *Mucus.* This principle is derived from the mucous membranes lining the urinary organs, and is always met with in minute quantity in healthy urine. Its chief importance, however, is in a pathological point of view, and when, from disease or other circumstances, it is inordinately increased, or changed in its properties.

Mucus, as derived from different parts of the body, seems to differ considerably in its nature; though, after all that has been done on the subject, it must be confessed that its chemical properties are but imperfectly understood. Generally speaking mucus is insoluble in water, though it possesses the property of absorbing a large proportion of that fluid, and of becoming thus transparent, and assuming a *glairy* appearance. It is also insoluble in acetic acid, nor is it coagulated by boiling. These properties sufficiently distinguish mucous from albuminous matters. In diseased states of the bladder enormous quantities of mucus are sometimes separated, the properties of which differ considerably from those of the healthy secretion, though I am not aware of any chemical tests at present that will give us much assistance in distinguishing the various diseased states of this secretion from one another. A great deal of important information, however, may be frequently derived from the different *appearances* assumed by this principle, some of which will be pointed out hereafter, though by far the greater part of them will not admit of description, but can be learnt only by observation and personal experience.

23. *Pus.* This principle is sometimes met with in the urine in great abundance. When nearly pure and unaccompanied by mucus, or when it contains blood, it may be supposed in general to be derived from an abscess. Most frequently, however, it is accompanied by mucus. Indeed mucus and pus (or something so like pus that it cannot readily be distinguished from it) a so nearly related as to run into each other by imperceptible grades; and when the mucus is in excess, or has preceded the pus, we may almost always conclude that some portion of the mucous membrane lining the urinary organs is the common source of both. At present I know of no test of easy application that will in all instances enable us to distinguish these two principles. Pus, however, when well marked, may be readily distinguished from mucus by being composed of *parti-*

cles. Hence when diffused through a fluid, which it readily may be, the fluid is rendered opake, though upon standing the pus subsides again to the bottom of the vessel in a state more or less pulverulent, and the fluid assumes its transparent character. Some further particulars respecting this principle will be found in a future part of this volume.

General Remarks.

From the preceding sketch we find that the most striking differences between the blood and the urine, is the complicated nature of the latter. The astonishing variety of substances formed from such a paucity of materials, naturally leads us to reflect upon the vast extent of the operation of the kidneys. On considering, however, a little more attentively, the nature of the operations of these organs, we shall find, as Berzelius has justly remarked, that *acidification* constitutes the chief feature in them. Thus, the sulphur and phosphorus of the blood are converted by the kidneys into sulphuric and phosphoric acids; a new acid, the lithic, is generated altogether, &c. Such, then, evidently is the natural and healthy operation of these glands. We find, however, that in certain forms of disease, this acidifying tendency is carried to excess, and nitric acid, oxalic acid, &c. are produced. On the other hand, it is occasionally suspended, diminished, or altogether subverted; and unchanged blood, or albuminous matter; neutral substances, as urea, or sugar; or even alkaline substances, as ammonia, lime, and magnesia, are separated in abundance; and the phosphorus and sulphur at the same time pass through the kidneys without being acidified.

With respect to the mode in which all the different substances existing in the urine are naturally combined, it is impossible to state any thing with certainty, except generally that the several acids divide the alkaline bases among themselves in the order of their respective affinities and quantities. The greatest difficulty which occurs among the salts, is with respect to the phosphoric and lithic acids and their compounds. There can be no doubt, however, as formerly stated, that the whole of both of these acids are in combination with some base or bases; otherwise the lithic acid could not be retained in solution. Yet the solution of these compounds reddens litmus paper very strongly; showing that the acids, though in a state of *combination*, are not in a state of *neutralization* (two very different things, though frequently confounded with each other); and we can only explain this by supposing that the affinities of the elements of the different salts are so balanced, that the ammonia of the super-lithate of ammonia, for example, is held too firmly in combination by its acid to be separated by the phosphoric acid of the super-phosphates.

With respect to the intimate nature of secretion, or the manner in which the constituents of the blood are changed into so many apparently different substances, we know still less at present than of the substances themselves. There is nothing, however, that forbids us to inquire into the subject as far as circumstances will permit; and by determining what can or cannot be, or rather what is or is not, done by the organs in question, we may, perhaps, be able hereafter to arrive at a certain degree of knowledge on the subject. This, however, is not my object at present; and I shall close these observations with a few remarks only on the modes in which functional operations are more particularly concerned in the production and modification of diseases.

In the first place there can be little doubt that functional operations in general, and more particularly those of glands, are regulated according to certain laws, and thus necessarily circumscribed within narrow bounds. It is indeed true that extraordinary operations of a vicarious nature are sometimes performed by particular organs, but such occurrences scarcely affect the general law; and no one, I presume, will readily assert that the kidneys, for example, can form any other substance as well as lithic acid, or, what amounts to the same thing, can form lithic acid from any substance indiscriminately presented to them. If this be admitted, the inference is obvious, that the kidneys must have the ingredients on which they operate, prepared for them in some uniform manner; and thus a series of preliminary operations is implied, every one of which must be presumed to be perfect, before the kidneys can be supposed capable of performing their duty correctly. The chief of these preliminary operations are digestion and assimilation; and hence it becomes evident that if these important processes are in any way deranged, those of the kidney will be more or less affected.

Secondly. A disposition to diseases of the urinary system, as well as of the contiguous organs at the same time, seems to be frequently inherited. Of this I have seen many examples; and it is often wonderful how curiously this tendency will be sometimes modified in different individuals of the same family: thus where a parent has laboured under disease of the kidney or bladder, one of the sons has been cut for the stone, another has laboured under disease of the rectum, the daughters have suffered from uterine affections, &c. Indeed I have frequently remarked, that when the males of a family have been subject to urinary diseases, the females have been more or less liable to diseases of the generative system.

Thirdly. Persons subject to urinary affections often suffer from different forms of these diseases at different periods of their lives; thus a person who has been subject to lithic acid deposites, will occasionally lose that form of diseased secretion, and pass mulberry calculi, and *vice versâ*. And we shall see hereafter that every other form of deposite is liable to be changed by circumstances into that of the phosphates. Again, I have known the son of a father who died of diabetes exceedingly liable while a young man, to lithic acid deposites; and on the other hand, have seen an instance in which one of a family much troubled with lithic acid deposites, died of diabetes, &c.

Lastly. It may be remarked in general, that when acids are formed in excess by the kidneys, the urine is commonly small in quantity and high coloured, and the disease inflammatory; when neutral or alkaline substances, the urine on the contrary is generally pale coloured and larger in quantity, and the diseases are those of irritation and debility.

The practical inferences to be drawn from these general remarks, which might be much extended, are most important, and should be constantly kept in mind. From them we learn the deep seated and constitutional character of urinary diseases in general; their intimate connexion with each other, and the important information respecting the nature of any particular disease, to be derived from the examination of the urine; they guard us also against the absurdity of trifling with supposed specifics; of considering the more rare forms of disease as anomalies, and, at the same time, direct us to modes of treatment founded on precise and rational principles.

Division of the subject.

The diseases connected with the urinary organs seem to be naturally divided into three classes.

1. *Functional* diseases; comprehending all those affections arising from a deranged operation of the kidneys.

2. *Mechanical* diseases; including all those arising from the mechanical irritation of solid foreign bodies, as calculi, &c.

3. *Organic* diseases, or those connected with disorganization of some portion of the urinary organs.

Of these three classes the first may exist independently of the two others. The second always implies the existence of the first, and is very frequently complicated with the third. The third may exist independently of the others, but most generally it is complicated with the first, and very frequently with both the first and second. These circumstances render it difficult, in a practical point of view, to follow the natural arrangement above-mentioned, and accordingly I shall consider the subject under two general heads only; namely, *functional* diseases, comprehending, as before-mentioned, all those affections arising from a deranged operation of the kidneys, but including likewise all sorts of mechanical deposites formed by and in those organs, as gravel, &c.; and, secondly, *organic* diseases, including not only, as before-mentioned, all those connected with actual disorganization, but likewise all sorts of urinary concretions of sufficient magnitude to be termed calculi.

I. The first general class of diseases, according to this mode of dividing the subject, will naturally arrange themselves under two heads, namely, *a.* diseases in which principles *soluble* in the urine are morbidly deranged in quantity or quality; and *b.* diseases in which principles *insoluble* in that secretion are similarly deranged.

a. The first of these divisions will include,

1. *Various forms of albuminous urine.*
2. *Anonymous diseases, in which an excess of urea is a characteristic symptom.*
3. *Diabetes.*

b. The second division will include,

4. *Lithic acid deposites.*
5. *Oxalate of lime ditto.*
6. *Cystic oxide ditto.*
7. *Phosphatic ditto.*

II. The second general class will comprehend the following subjects:

1. *Origin and increase of urinary calculi in the kidneys, with inflammation and various organic affections of these organs.*
2. *Origin and increase of calculi in the bladder, with organic diseases of this organ and the prostate gland.*
3. *General observations on the periods of life, sex, &c. subject to calculous affections, &c.*

To these will be added,

4. *Practical rules for determining the nature of the affection and its appropriate remedies from the properties of the urine, and other symptoms; being a general recapitulation of the whole subject under other points of view.*

The above may be considered as comprehending all the derangements of the urinary system at present known as distinct and separate diseases. Of minor derangements of sufficient importance only to be considered as *symptoms*, it is not my intention at present to treat, though many of these will be mentioned incidentally in the course of the present volume.

I. OF FUNCTIONAL DISEASES.

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a. DISEASES IN WHICH PRINCIPLES SOLUBLE IN THE URINE ARE MORBIDLY DERANGED IN QUANTITY OR QUALITY.

CHAP. I.

Diseases in which the presence of an albuminous Principle is the characteristic Symptom.

The albuminous matters occurring in the urine may be considered as of two distinct kinds; namely, chylous, and serous; in the first case they resemble those constituting the chyle, in the second those existing in the serum of the blood. Of these two affections, the first, according to my observations, is the most frequent; the last is much more rare, or at least much more difficult to distinguish. It may, however, be remarked, that strongly defined instances of either variety of these affections are not very common; and that by far the most frequent form which the disease assumes seems to be of an intermediate character; that is to say, the albuminous matters partake in some degree of the properties of both those of the chyle and serum, though generally mor- of those of the chyle.

In the first of these forms of disease, or *chylous* urine, the albuminous principles sometimes exist in very large proportion, in which case the urine undergoes a kind of spontaneous coagulation; but most frequently their quantity is small, when they are held in solution in it. In these cases the urine is almost invariably pale coloured, and of moderate or low specific gravity. Occasionally it is opalescent when voided; and in all instances, on being exposed to the action of heat, it becomes opaque, and deposites flakes of albuminous matter. It is prone to decomposition, especially what is passed some time after meals, which is generally more loaded with albuminous matter, and consequently possesses all the above properties in a more eminent degree. Sometimes what is voided at this time throws up a sort of creamy matter upon its surface, after standing some time. This affection of the urine exists in every possible degree, from barely perceptible traces of an albuminous principle to perfect chyle.

With respect to the symptoms, it will be occasionally found, that an albuminous condition of the urine exists to a considerable extent without the consciousness of the patient. Generally, however, there is a frequent desire to pass water, and for the most part decided diuresis, I have never known albuminous urine attended by positive pain, though the patient, for the most part, complains of certain indescribable sensations, which render him conscious that all is not right. In severe cases, where the drainage from the system is greater than natural, there are, as might be expected, an inordinate craving for food, and other symptoms somewhat resembling diabetes.

The following interesting case presents an extreme instance of this affection. As such are very rare, I shall give rather a minute account of the urine in its different states:—The patient was a married woman, about thirty years of age. The disease first made its appearance about twelve months before, and proceeded gradually. Her appetite was greater than natural, and she had some other symptoms of diabetes; but her general health seemed very little affected; and almost the only inconvenience she experienced was a constant difficulty of passing her water, owing to the coagula which formed in the bladder blocking up the urethra.

November, 1818, I received three specimens of this woman's urine, namely, one voided in the morning, another a little after breakfast, and a third in the evening.

The first specimen, voided in the morning, consisted of a solid jelly-like mass, or coagulum, of a pale amber colour. This coagulum was of an extremely delicate texture; and, on being submitted to a gentle pressure, or even allowed to drain, parted with a large proportion of a serous fluid of the colour above-mentioned, and at the same time became exceedingly reduced in bulk, and assumed the appearance of a red fleshy-like mass of a fibrous texture, which, upon examination, was found to have all the properties of the fibrin of the blood, mixed with a few of the red particles of the same fluid. The specific gravity of the serous portion was 1·019. Its smell was very faintly urinous. It did not affect litmus or turmeric paper; and although it contained a large proportion of albuminous matter coagulable by heat, it yielded distinct traces of the presence of urea.

The second specimen, voided after breakfast, resembled the first in its general characters, but differed from it in some minor particulars. Thus the serum was more of a whey colour, the fibrous coagulum was less, and more compact and firm, and contained, entangled in its texture, a larger proportion of the red particles of the blood. The specific gravity of the serous portion was only 1·0124. It contained, however, a considerable proportion of albuminous matter, though it did not coagulate by heat. It contained also a sensible proportion of urea.

The third specimen, voided in the evening, after an early dinner taken about noon, was the most remarkable, and so closely resembled chyle in all respects, that I am doubtful, if it had been brought to me as a specimen of that fluid, whether I should have discovered the imposition. It consisted of a solid coagulum of a white colour, and assuming the shape of the vessel, like blanc-mange. On being submitted to a gentle pressure, and permitted to drain, the residual solid portion was, like that of the others, small in quantity, but whiter than the coagula of the other specimens. It was, however, intermixed with strings of a firmer consistence, and of a red colour. The serous portion was white and opaque, like milk; and on being heated, and permitted to stand at rest for some time, threw up a substance upon its surface very like the cream of milk, and which, like that substance, was found to contain a considerable proportion of a butyraceous principle. Its specific gravity was 1·0175; and its smell was not urinous, until after it was concentrated by evaporation, when it became slightly so; and in this state yielded faint, though distinct, traces of the presence of urea. It was not coagulable by heat, though it contained abundance of albuminous matter, chiefly, however, in that state in which it exists in the chyle, and which I have elsewhere denominated *incipient* albumen.* One hundred grains of this serous fluid, evaporated to dryness, left about seven grains, half a grain of which only was soluble in alcohol, and consisted of urea, a little fatty matter, and the other principles commonly found in all animal fluids; while the remaining six grains and a half consisted chiefly of the imperfect albuminous and fatty principles above mentioned, with some salts. It burnt with a flame, yielded an odour something like that of cheese, and left a coal difficult to incinerate, but which, when burnt, was found to contain a considerable proportion of earthy salts, consisting chiefly of phosphate of lime.

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* Annals of Philosophy, xiii. p. 20.

I had an opportunity of examining this woman's urine after fasting twenty-four hours. The coagulum was now much smaller in bulk, and seemed to contain more red particles. The serous portion was nearly transparent, and possessed in a considerable degree the colour and other sensible properties of the urine. Its specific gravity was 1·021; and it was found to contain abundance of urea, and a large proportion of more perfect albuminous matter than either of the other specimens.

The above remarkable case occurred to my friend Dr. Elliotson, to whom I was indebted for the opportunity of examining the urine. From particular circumstances, no plan of medical treatment was adopted, and he lost sight of her till November, 1822, a period of *four* years. At this time she appeared in good health; but informed him, that the urine had remained in precisely the same state ever since he had last seen her, and still continued so, and that in the interim she had become pregnant, and borne a living child.

By way of illustrating slighter cases of this form of disease, I shall relate one which occurred to me several years ago, before I had formed the opinion that chyle, and not blood, is occasionally the source of the albuminous principle.

The patient was a man sixty-four years of age, frequently dyspeptic, and subject to bilious obstructions: a martyr to gout; and had numerous lithic concretions both in his hands and feet. His urine was first examined under a paroxysm of gout, before any œdematous swelling had taken place, and found albuminous in a great degree. Its specific gravity was 1·0141. It became turbid at 120°; and as the temperature advanced, formed heavy flakes. It contained very little saline matter, and possessed only slight traces of urea or lithic acid. After having been kept some days in the bottle, it acquired the smell of sour whey, and very strongly reddened litmus, evidently from the developement of acetic acid. The animal matter present differed from albumen, and approached in its properties to curd, though it was evidently a substance distinct from either: in short, it had all the properties of the imperfect albuminous matter found in chyle.

The above case was first described by Dr. Scudamore in 1816, when I had an opportunity of seeing the urine, which was frequently examined, and ascertained to remain in the same state for several years afterwards, when the patient was in his ordinary state of health. During this period the quantity secreted was always abundant, and its specific gravity generally varied from 1·0041 to 1·0076.

My chief object in bringing forward the above two cases has been, to demonstrate, from their well-marked character, the *chylous* origin of the albuminous matter present in the urine, a circumstance, I presume, that no one who has attended to the subject can possibly question.

A chylous condition of the urine may occur at all ages; but those in whom I have seen the ordinary forms of the affection most frequently take place have been past the middle age, of an irritable scrofulous habit and impaired digestive powers, and who frequently have been free livers. In such habits more particularly, and perhaps in any under certain circumstances, this condition of the urine may be excited by a variety of causes, such as a long course of mercury, stimulating diuretics, violent passions of the mind, exposure to cold, &c. Frequently, however, it will be found that this affection cannot be traced to any particular cause.

With respect to the tendency and danger of this affection we have seen that slighter degrees of it, in which the tendency may be considered as simply *passive*, can exist for years, without apparently becoming worse, or producing any serious effects on the constitution.* The danger of the affection, however, must of course increase with its permanency and degree, though it may be remarked, that even in the extraordinary case above related, which may fairly be considered as of an extreme character, the constitutional symptoms were by no means severe; and, what is still more singular, and apparently characteristic of its simply passive character, it did not even seem to interfere with the important function of generation.

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* Dr. Wells, in the paper referred to below, has rendered it probable that in one case the urine was albuminous for a space of *nine* years.

From what has been said, it will be readily seen, that in this condition of the urine we can hardly lay down any specific plan of treatment, which must, therefore, depend very much on the nature of the disease with which the affection happens to be complicated. Considered as a symptom, however, it may, in many instances, be useful in directing us to avoid certain remedies, such as stimulating diuretics, especially those of the alkaline kind, &c. the employment of which, for the most part, will be likely to do mischief in this affection. Sedatives and tonics also may be occasionally useful.

With respect to the second form of albuminous urine, which we have termed *serous*, I am able to say very little.

It has been supposed, that in such cases an inflammatory state of the system is present, and that the separation of serum with the urine is analogous to the serous effusion that takes place from inflamed surfaces: hence Dr. Blackall has particularly insisted upon the use of this occurrence as a diagnostic symptom, in directing the use of the lancet in some cases of dropsy.*

In the first place, with respect to the existence of unaltered serum in the urine, it must be either of rare occurrence, or very difficult to discriminate; for, as before observed, by far the greater proportion of the cases of albuminous urine that have fallen under my own observation, has seemed to me to belong rather to the *chylous* variety than the *serous*: I admit, indeed, that in a few cases of dropsy the albuminous matter appeared to possess more of the *serous* character; but except in one or two instances, in which the lithate of ammonia also abounded in the urine in great quantity,† I could not discover any thing else remarkable in these cases. In the cases, however, in which the lithate of ammonia abounded, the albuminous matter seemed not only to partake more decidedly of the serous character, but the strength of the pulse, and determination to the head, also sufficiently indicated the use of the lancet, which was employed freely with great advantage; one of these cases, however, after all, terminated in apoplexy, which proved fatal.

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* Dr. Wells has remarked, that in the dropsy, which sometimes follows scarlatina, as well as occasionally in other dropsical affections, *real blood* is sometimes met with in the urine; and the same has been remarked by other authors. The notion also, that albuminous urine is "connected with too great action in some part of the system," seems to have originated with Dr. Wells. See Transactions of a Society for the Improvement of Medical and Surgical Knowledge, vol. iii. p. 167, *et seq.*

† Dr. Wells states, that he never but in two instances saw a pink-coloured sediment in albuminous urine. This circumstance is not very common, but when it does occur, the urine presents an interesting phenomenon on exposure to heat; that is to say, it has the property of becoming *opaque*, at both a *high* and a *low* temperature, while there is an *intermediate* point at which it is perfectly *transparent*. The reason is obvious; on cooling, the amorphous sediment is deposited, thus rendering the urine *opaque*, as in other instances; on exposing it to a temperature of about that of the human body, this sediment is redissolved, and

How far these remarks may militate in favour of Dr. Blackall's opinion, I do not know. For my own part, I confess my experience on this point has been limited, and that I am unable to come to any certain conclusion on the subject, which may, indeed, in some degree, be considered as falling without my present design.

it becomes *transparent*; but on continuing the heat the albuminous matter begins at length to coagulate, and thus it is again rendered *opaque*.

CHAP. II.

Diseases in which an Excess of Urea is the Characteristic Symptom.

THE proportion of urea in healthy urine is such that, on the addition of nitric acid, no crystallization takes place till the urine is concentrated by evaporation. In a variety of cases, however, the quantity of this principle is so increased, that the above effect is produced without any concentration. This is always a mark of some derangement in the health, and occasionally appears to be characteristic of certain varieties of disease which have probably been frequently confounded with diabetes, and which it is my principal object to describe in the present chapter. Before, however, I proceed, I shall briefly notice some other forms of disease in which the proportion of urea is greater than natural, with the view of contrasting them with the diseases in question, and thus of rendering the distinction more complete.

Whenever the specific gravity of the urine is high, for example, above 1·025 or 1·030, the proportion of urea, in common with the other principles, is necessarily larger than natural, and in this case spontaneous crystallization will frequently take place on the addition of nitric acid. This concentrated state of the urine not unfrequently takes place in febrile and other diseases, and is quite unconnected with any disease of the urinary organs, and appears to depend upon a diminished secretion of water only. Hence, although this abundance of urea, as in all other cases, may be considered as indicative of disease, yet in the present instance it is obviously no more so than the abundance of the other principles, and consequently leads to no particular plan of treatment, which must be regulated by the general nature of the disease.

In other instances an excess of urea, as compared with the other ingredients of the urine, is actually present. This happens, for example, not unfrequently in the urine of children and others depositing the phosphates. In such cases, however, more obvious and urgent symptoms are commonly likewise present. Hence the symptom of excess of urea, though important, cannot be considered as characteristic, and consequently should have little influence in directing our practice, which, as before, must be regulated by the more prominent symptoms.

Those diseases in which an excess of urea may be considered as in some degree characteristic, do not appear to have been hitherto distinguished, but have been probably confounded with other diseases, and particularly with that form of diabetes which has been sometimes denominated diabetes *insipidus*. These diseases, however, differ considerably from diabetes, as the following observations will show.

The average specific gravity of the urine in these complaints seems to be a little above 1·020, and occasionally to vary from 1·015 to 1·030. Most generally it is pale, but occasionally it is high coloured, and exhibits somewhat the appearance of porter, more or less diluted with water; and this variety in appearance not unfrequently takes place in the urine of the same person. When first voided, it reddens litmus paper. For the most part it is entirely free from sediment, except the mucous cloud of healthy urine; and the only remarkable property which it appears to possess is that of containing abundance of urea, so that on the addition of nitric acid, crystallization speedily takes place. From the quantity of urea present, it is very prone to decomposition, and soon becomes alkaline, especially in warm weather.

There is almost constantly in these diseases, a frequent and urgent desire of passing water both by night and day. This desire is for the most part evidently excited by actual *diuresis*, or the increased quantity of urine; but frequently it cannot be ascribed to this cause, as the quantity voided at one time is often by no means considerable; though in almost every instance that has fallen under my observation, the total quantity voided during any given time has appeared to be greater than natural. The quantity appears also to be particularly liable to be increased by cold weather, and by all causes producing mental agitation. There is sometimes a sense of weight or dull pain in the back; but this is by no means a constant symptom. There is also occasional irritation about the neck of the bladder, which sometimes extends along the urethra. The functions of the skin appear to be natural; at least in every case which has come under my own observation perspiration has been rather easily induced. The pulse is not affected. There is no remarkable thirst, nor craving for food, except in extreme cases, nor are the functions of the stomach and bowels much deranged: hence for the most part the tongue is clean, and the dejections regular and apparently natural.

In most of the cases of this disease which have hitherto fallen under my own immediate observation, the subjects have been middle-aged men, of thin and spare habit, with a sort of hollow-eyed anxiety of expression in their countenance; free from gout and constitutional disease in general, and, as far as could be ascertained, from any organic defect in the urinary organs. In every instance they had been induced to apply for medical advice, not so much from the pain, as from the inconvenience, of the disease, and the dread of its ending in something worse: and, what may be worth remarking, in several instances confessed that they had been addicted to masturbation from very early youth.

With respect to the causes of this affection, they are doubtless very various: whatever debilitates the system, and particularly the urinary organs, may give origin to it. Hence it may be induced by all those circumstances which give origin to albuminous urine, diabetes, and the deposition of the phosphates, with which diseases, as we shall find hereafter, it seems to be intimately connected.

I have had no opportunity of ascertaining the progress of these diseases; but think it extremely probable that, if permitted to proceed, some of them will terminate in diabetes, or in a deposition of the earthy phosphates. There seems, however, to be considerable variety in their symptoms as well as their nature; and I even think it probable that future observations will make us acquainted with many diseases having this symptom of abundance of urea and those which generally accompany it, in common, though differing altogether in their nature in other respects. This want of uniformity in the nature of the disease of course precludes the idea of any uniform plan of treatment, which must be adapted to circumstances. In most of the cases, however, which have hitherto fallen under my own observation or knowledge, sedatives, and particularly opium, have been the most efficient remedies; and by the judicious use of these, combined with other appropriate medicines, it is probable that in most instances the disease can be suspended, if not removed altogether. I select the following two cases, as illustrating more fully the preceding remarks.

The first case I shall relate, and which was indeed the one that originally drew my attention to this disease, was that of a gentleman about forty years of age, whose general appearance and constitutional habits coincided precisely with those above detailed. He had been subject to the complaint a considerable time, but latterly it had much increased, and he had now a very frequent desire to pass water, especially when under the influence of mental agitation, or when exposed to the cold air. The urine was generally of a brown porter colour, and not much more abundant than natural. The specific gravity of the specimen I examined was 1·0237. In this specimen the urea was most strikingly abundant, and there was also a little lateritious sediment. Occasionally he informed me that he passed urine of a very pale colour, and in this case it was more abundant, and was probably of much less specific gravity. He had no thirst, and the functions of the skin appeared to be natural. He had lately, however, recovered from a slight feverish attack, and he felt occasionally some slight pain in the region of the liver: the tongue was also slightly furred, and the bowels rather irregular. From the presence of these latter symptoms I drew the conclusion that the affection in question was connected with some derangements of the functions of the liver, and of the general health, and accordingly ordered him mercury in alterative doses, with purgatives and the other means usually had recourse to on such occasions. About a month afterwards I saw him again. The urine was now free from sediment, and its specific gravity was reduced to 1·019; but it still exhibited the same brown colour, and the same great excess of urea, as before; and though his general health was evidently improved, the urinary complaint was in no degree diminished. He was now ordered a bitter infusion, containing potash and opium, and to keep his bowels regular by the occasional use of the alterative laxative pills previously prescribed. Under this plan the complaint sensibly became better in a few days; and in three weeks afterwards, when I saw him, was very considerably diminished. The urine was indeed of the same general appearance as before; but its colour was lighter, its specific gravity reduced to 1·0155, and the proportion of urea, though still excessive, was diminished. By persevering in this plan for some time, he became almost entirely free from the complaint, and continued so for some months, when it returned again in a slight degree. Similar means were again had recourse to, and it again yielded; since which time it has returned at intervals of some months (more frequently during the winter), but has always given way to the use of opium in very moderate doses, as, for example, Gutt. x. or xii. of the tinct. opii in a glass of soda-water once or twice a day. It is proper, however, to observe, that this gentleman's urine, though much improved, has never become quite natural, either in its appearance or in the proportion of the urea; and I think it probable that the disease will be occasionally liable to return for some time at least to come. I cannot, however, venture to give a decided opinion respecting its termination; though I think it not unlikely that, by perseverance in the above plan of treatment, it may ultimately be conquered.

The second case I shall relate, is one that occurred at St. Thomas's Hospital, to my friend Dr. Elliotson, who furnished me with the urine for examination every week, so as to enable me to ascertain the effects of the remedies employed.

March 6, 1819. —— Rodman, aged fifty-five. Symptoms resembling those of diabetes.—There is a constant craving for food.—Sensation of cold over the body.—Frequent desire of voiding water, which in 24 hours amounts to *sixteen pints.*

The urine of this man was pale coloured. Its specific gravity was 1·020, and it contained a very large porportion of urea, but not the least particle of saccharine matter. On standing it also deposited crystals of lithic acid. Ordered *gr.* 1½ *opii bis die.**

March 20.—Feels much better. Urine reduced to two pints in 24 hours. *Pergat.*

The urine was now somewhat deeper coloured, and deposited a copious sediment consisting partly of lithic crystals and partly of lateritious sediment. Its specific gravity was increased to 1·0344, evidently from its having become more concentrated than natural. The quantity of urea was abundant, but not in the proportion in which the urine was concentrated.

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* Opium was ordered in this case by Dr. E. on the supposition that the disease was diabetes.

This man became so well shortly after the above date, that he did not return again to the hospital till

August 19.—Disease returned six weeks ago.—Feels as ill as ever.—Very weak.—Bowels costive. —Quantity of urine in 24 hours about four pints. Ordered *opium as before.*

The urine now was transparent. Its specific gravity was 1·0231, and urea was abundant.

Under the above plan he again became speedily better, and soon afterwards ceased to attend at the hospital. In September of the following year, however, he again applied to Dr. E. on account of another and very different disease. The specific gravity of the urine was now 1·0282. It abounded in lithic acid, *but contained no excess of urea;* and he had been quite free from his former complaint for upwards of twelve months.

These two cases may be considered as exhibiting the extremes of this form of disease, which, from subsequent experience, I am disposed to believe is rather uncommon. I have, however, seen several intermediate grades of the affection, sometimes distinctly marked, and at other times variously complicated with different complaints requiring other treatment. In one instance it occurred in a young man whose mother and uncle had laboured under diabetes. In another, it preceded the deposition of the phosphates in the urine—thus apparently pointing out some analogy with these affections, as before noticed, and as will be more particularly shown hereafter. In most instances sedatives formed a part of the plan of cure, and were always found to be more or less beneficial, particularly when the quantity of urine was greater than natural. Purgatives and alteratives also were generally found useful. In one instance, chiefly by way of experiment, I ordered copaiba; but it decidedly increased the complaint, which I apprehend will be found to be the case with all stimulating remedies.

CHAP. III.

Diabetes.

The term *diabetes*, implying simply an increased flow of urine, is applicable to any disease in which that symptom is present in a remarkable degree. This general use of the term, however, has caused a great deal of confusion; as a variety of diseases, differing altogether in their nature, except in the accidental circumstance of being accompanied by *diuresis*, or a large flow of urine, have in consequence been confounded with one another. Some of these have been of a temporary nature, as various nervous affections, local irritation about the bladder or urethra, &c. Others have been of a more permanent description—such, for example, as the diseases described in the last two chapters. To prevent this confusion in future, I would recommend that the term be restricted to those affections in which the urine is *saccharine*. Hence I would define diabetes to be a disease in which a saccharine state of the urine is the characteristic symptom.

The urine of diabetes is almost always of a pale straw or greenish colour. Its smell is commonly faint and peculiar, sometimes resembling sweet whey or milk. Its taste is always decidedly saccharine in a greater or less degree. Its specific gravity has been stated to vary from 1·020 to 1·050. I have seen it higher than this, but never so low. The quantity of urea is almost always very much diminished, though I have never met with a specimen in which it was entirely absent. It contains, for the most part, little or no lithic acid. The usual saline matters existing in healthy urine are met with in diabetic urine in nearly the same relative proportions, but their absolute quantity is very much diminished. Sometimes diabetic urine contains a little blood;* and not unfrequently albuminous matter analogous to that of the chyle. I have seen it also contain a white milky-like fluid precisely similar to chyle, which slowly subsided to the bottom of the vessel. In this case the vinous fermentative process was induced very rapidly in the urine, the chylous matter apparently acting like yeast.

The following table, constructed by Dr. Henry, shows the quantity of solid extract in a wine pint of urine of different specific gravities, from 1·020 to 1·050. In the experiments which furnished the data of this table, the urine was evaporated by a steam heat till it ceased to lose weight, and till it left an extract which became solid on cooling.†

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* See Watt's Cases of Diabetes, p. 47, 74.

† See Annals of Philosophy, vol. I. p. 27.

Specific gravity compared with 1000 parts of water at 60°.	Quantity of solid extract in a wine pint.	Quantity of solid extract in a wine pint, in			
	grains.	*oz.*	*dr.*	*scr.*	*grs.*
1020	382·4	0	6	1	2
1021	401·6	0	6	2	1
1022	420·8	0	7	0	0
1023	440·0	0	7	1	0
1024	459·2	0	7	1	19
1025	478·4	0	7	2	18
1026	497·6	1	0	0	17
1027	516 8	1	0	1	16
1028	536·0	1	0	2	16
1029	555·2	1	1	0	15
1030	574·4	1	1	1	14
1031	593·6	1	1	2	13
1032	612·8	1	2	0	12
1033	632·0	1	2	1	12
1034	651·2	1	2	2	11
1035	670·4	1	3	0	10
1036	689·6	1	3	1	9
1037	708·8	1	3	2	8
1038	728·0	1	4	0	8
1039	747·2	1	4	1	7
1040	766·4	1	4	2	6
1041	785·6	1	5	0	5
1042	804·8	1	5	1	4
1043	824·0	1	5	2	3
1044	843·2	1	6	0	3
1045	862·4	1	6	1	2
1046	881·6	1	6	2	1
1047	900·8	1	7	0	0
1048	920·0	1	7	1	0
1049	939·2	1	7	1	19
1050	958·4	1	7	2	18

This table enables us to ascertain with considerable precision the quantity of solid matter voided by a diabetic patient in a given time. Thus, suppose ten pints are passed in 24 hours, of the average specific gravity 1·040, it is evident that this will contain $\overline{10 \times 1 .. 4 .. 2 .. 6} = 15 .. 7 .. 2$, or upwards of a pound and a quarter of solid extract!

A *saccharine* condition of the urine, as before observed, is the characteristic symptom of diabetes; but another most striking and constant symptom is *diuresis*, or an increased secretion of that fluid, and sometimes the quantity of urine voided is enormous. Thus, cases are on record in which 30 pints have been discharged every 24 hours, for weeks and even months together. In such cases the quantity of urine voided has been said to be more than double the whole ingesta—a circumstance which physiologists have puzzled themselves a good deal to explain. I believe, however, that in the best authenticated cases this enormous difference between the quantity of ingesta and urine has not been observed.*

The constitutional and other affections usually accompanying a saccharine state of the urine are summarily enumerated by Mr. Watt as follows:

"The appetite is usually better than in health. Uneasiness in the stomach after meals; thirst urgent; the mouth dry and parched; tongue white and foul, sometimes unnaturally clean and red; tough disagreeable mucus in the throat; depraved taste; skin dry and unperspirable; considerable emaciation; weariness, and aversion to exercise; loss of strength; pain and weakness in the region of the kidneys; irregular, generally costive state of bowels; some degree of inflammation and uneasiness about the external orifice of the urethra; loss of virility; chilly state of body; cold feet; a tendency to œdema; heat and uneasiness in stomach and bowels; acid eructations; flatulence; eyes muddy and painful; indistinct vision; vertigo; head-ach; dyspnœa on the least exertion; gums spongy and ulcerated; weight and tenderness about the præcordia; a tendency to sigh; listlessness; mind weak and peevish; spirits greatly exhausted."* The breath (and frequently the person of the patient) exhales a peculiar *hay-like* smell. The pulse variable, but generally in the latter stages, weak, and sometimes irregular.

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* See Watt on Diabetes, p. 158.

Such is the dreadful catalogue of evils more or less of which usually harass the unfortunate victims of this formidable disease. If permitted to proceed unchecked, the debility increases, and some pulmonic symptoms, accompanied by hectic fever, generally make their appearance, which sooner or latter prove fatal. Occasionally it terminates in incurable dropsy; and sometimes the patient is cut off suddenly, either by apoplexy, or by a peculiar affection of the stomach, brought on by improper food, or over distension of that organ.

In endeavouring to explain the affections accompanying diabetes, we must consider the disease in a two-fold light;—first, as a simple saccharine condition of the urine, without any regard to its quantity; and, secondly, as a similar condition of the urine, accompanied by more or less of *diuresis*.

With respect to the first of the above forms of disease, no one seems hitherto to have distinctly described it. Its existence, therefore, at least as an original form of disease must in the present state of our knowledge be considered as somewhat hypothetical. That such a form of the disease however can exist, seems to be proved by the fact, that diabetes may be so far cured as to be literally reduced to the state in question: that is to say, the quantity of urine may be rendered natural, and all the usual symptoms of the disease be much relieved, and *yet the urine remain saccharine.* Now if a common case of diabetes can be reduced to this state, there seems to be no reason why the disease may not originally exist, for some time at least, in a similar form.

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* See Watt on Diabetes, p. 196.

In further support of this opinion also it may be stated, that I have seen a case in which the usual symptoms of diabetes subsequently manifested themselves in their worst form, and in which the patient's attention was attracted by the peculiar *qualities* of the urine, long before its *quantity* struck him as any thing remarkable. In this case it was observed, that wherever the urine happened to fall on the dress, an imperfect crystallization took place, and the part became stiff and clammy, and attracted the dust. I was well acquainted with this gentleman, and in the habit of meeting him as a friend for several years before he was known to have the disease in question, and consequently during the time when the urine possessed the above properties. He was of a thin spare habit, and at the above period very nervous, and subject to occasional slight fits of gout, which latter affection has entirely left him since the complaint has assumed the more decided character of diabetes. In this case I cannot help thinking, that a saccharine condition of the urine existed in a greater or less degree for a considerable time before the complaint became complicated with *diuresis*. I may also remark, that a second case, very similar to the above, came to my knowledge some time ago, but from my not being acquainted with all the particulars so thoroughly as I could wish, I do not lay any stress upon it.

The first symptom, as is well known, which usually attracts the patient's attention, as well as that of the physician, in this disease, is the increased flow of urine. Whether this be a consequence of the *saccharine* condition of the urine, or whether it depend upon other causes, is unknown. However this may be, the *quantity* of the urine seems in some degree to be a measure of the severity of the disease; for the greater the flow of urine, the greater, for the most part, are the specific gravity and proportion of sugar which it contains, and the more severe the patient's sufferings. In this form of the disease, an enormous drainage from the system evidently takes place of what must be considered as essential to its preservation and health; and it is probably to this enormous drainage, and not to the mere saccharine condition of the urine, that a great many of the most distressing symptoms usually occurring in diabetes are to be referred. "The loss of so much matter," says Dr. Elliotson very justly, "from the system, sufficiently explains the hunger, the feeling of emptiness and sinking in the stomach, the emaciation, debility, anaphrodisia, coldness of the legs, pains both of them and of the loins, the depression of spirits, &c. without attributing the disease to the stomach or the kidneys exclusively. The excessive escape of fluid, or, when this does not take place, the feverishness, equally explains the thirst and dryness of the skin." *

I do not mean to assert that a saccharine condition of the urine exists for some time without *diuresis* in every case of diabetes. In particular habits, certain causes, such as exposure to cold, the drinking of cold water when the body has been warm, &c. have apparently produced this disease at once in its worst form. Even in such cases, however, a doubt has frequently arisen in my mind, whether some sort of predisposition to the disease has not existed in individuals so affected; for it is well known, that such causes do not *always* produce diabetes, but on the contrary very rarely; and this doubt has been corroborated no less by some facts that have come to my knowledge, and to be presently related, respecting the hereditary nature of these affections, than by such instances as the following, which I quote from Dr. Marsh. A patient of his labouring under confirmed diabetes distinctly traced the apparent origin of the affection to exposure to cold at sea during a storm, in which the loss of the vessel was hourly expected.—"He was four days at sea, and during the greater part of the time was to his knees in water; he was chilled with cold, and for the last two days there was not any supply of provisions. After quitting the vessel he felt himself constantly chilly, and could not by any means (to use his own expression) 'get warmth into him.' Before this time he conceived himself in perfect health, but immediately afterwards decided symptoms of the affection in question manifested themselves." Dr. M. had at the same time under his care in the hospital another man, who had sailed in the same vessel, and was exposed to the same circumstances as the one who had diabetes. "He in like manner for some time afterwards felt cold and chilly, but the disease with which he was attacked was not diabetes but *intermittent fever*," to which it seems he had a predisposition. * And if we take into account the probable fact, not indeed mentioned by Dr. Marsh, that the great majority of the passengers was not, under precisely similar circumstances, affected with any disease at all, or at most a common cold, how are we to explain the fact of that particular individual getting diabetes, except on the supposition that he already inherited a predisposition to the affection?

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* Numerous Cases illustrative of the Efficacy of Hydrocyanic or Prussic Acid in Affections of the Stomach, &c. p. 90.

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* See Dublin Hospital Reports, vol. iii. p. 430. It gives me pleasure to state, that before I had seen Dr. M.'s excellent paper I had come to similar conclusions with himself on some points connected with this disease; and, perhaps, on those points in which we appear to differ, the differences may be more apparent than real.

That a predisposition or tendency to this affection exists in some families I cannot doubt, as I have now witnessed four distinct instances of this circumstance. The first was that of a young gentleman between 20 and 30 years of age, whose mother and uncle had died of the disease, and who feared that he laboured under the disease himself, as he appeared to have some of the symptoms. On examining the urine, however, I found no saccharine matter, but a great excess of urea, which seems to constitute the first step, in some instances, towards the presence of saccharine matter; but independently of this, the circumstance that two individuals, brother and sister, of the same family died of the disease, is sufficient to mark the *family* nature of the affection. The second case was that of a lady about 50 years of age, whose brother or sister, I do not remember which, had died of the same disease. The third case was that of a young girl about 10 years of age, in whom the disease proved fatal, and whose father, two or three years before, had died of a similar affection. And it may be remarked, that in August last I was requested to examine the urine of another girl of the same family, and about the same age, who it was feared had a tendency to the same affection. The urine contained no sugar, but a great excess of urea, thus clearly marking the tendency to the affection. The fourth instance was that of a gentleman who died of this affection at the age of 54, and whose father for many years before his death was stated to have laboured under the same disease. What is remarkable and well worth mentioning, this gentleman's son, who was about 30 years of age, stated that he was much troubled with lithic acid gravel.

From these circumstances, then, and others that, perhaps, might be mentioned, I am induced to believe, that a tendency to this affection, frequently inherited, and amounting, perhaps, in some instances, to an actual saccharine condition of the urine, exists in certain individuals, which on being roused or called into action by some favourable exciting circumstance, such as exposure to cold, or any thing inducing feverish or inflammatory action, becomes for the first time complicated with diuresis, and thus assumes all the well-known characters of diabetes. I mean to say, that such appears to be a frequent origin of this affection; but I by no means deny that many causes of a remote or predisposing nature really exist, such as long continued intemperance, and especially the immoderate use of spirits, severe evacutions, excessive labour joined with a poor acescent diet, some peculiar injury or affection of the spinal nerves, &c. any one or more of which concurring with a favourable circumstance more immediately of an exciting kind, may in some instances actually produce the disease in an individual not originally disposed to it.

Although we have thus rendered it probable that even a saccharine condition of the urine may exist for a considerable time, without becoming complicated with diuresis, and consequently with comparatively little inconvenience to the patient; yet when diuresis has once taken place, and been permitted to continue for some time, the character of the disease seems to be changed and rendered much more formidable; for though in most instances the tendency to diuresis may, by the judicious application of remedies and attention to diet, be, perhaps, very much diminished, or altogether removed, yet the difficulty of preserving the patient in this improved state is very great, and the affection is liable to be reproduced by the slightest exposure to exciting causes; more especially when the complaint had been previously of long standing, or had been present in a very great degree. Hence such an individual may be considered as existing on the brink of a precipice, and the general prognosis in diabetes must be always considered as very unfavourable.

The *proximate* cause of diabetes is exceedingly obscure. A great variety of opinions has indeed been advanced on this point, but as the subject has hitherto received no satisfactory elucidation from *post mortem*, or other inquiries, and is actually at this moment not understood, I do not think it necessary to enter upon it here. I have often thought, however, that there is nothing more wonderful about this than in any other animal process, and that if we understood how the animal economy forms fat, or the liver bile, we should be at no loss to understand how the kidneys sometimes form sugar.

With respect to the *treatment* of diabetes, this has been as various as the opinions respecting its nature; and, perhaps, there is no disease in which so much mischief has been done upon false principle and by random experiment, as in this. For my own part, I have no hypothesis on the subject, and, therefore, shall proceed to lay down such a plan of treatment as seems to be best sanctioned by general principles and experience.

I have stated above, that in a practical point of view, diabetes may be considered in a two-fold light; as a simple saccharine condition of the urine, without any increase in its quantity; and as complicated with a preternatural flow of that secretion. Want of attention to this simple distinction has caused great confusion in the history of the disease, and substances in consequence have been extolled as remedies which have acted simply by diminishing the flow of urine and its consequences, without altering in the least degree its saccharine condition. With respect, indeed, to the improvement of the qualities of the urine, it is exceedingly doubtful if there be any remedy that exerts a specific action in this way—certainly at least there is none at present known. If, therefore, this point be effected at all, it must, I think, be accomplished through the medium of those remedies that have a tendency in the first place to diminish the quantity of the urine, and to restore the general health: at any rate these are necessary as preliminary steps, for it seems to be quite absurd to look for any improvement in the quality of this secretion while its quantity remains unnatural.

Without entering into any speculative views of its nature, the circumstances which, upon general principles, seem more particularly to require to be combatted in diabetes, are the feverish excitement and nervous irritability always more or less present. These of course include the thirst, dryness of skin, and other analogous symptoms. As to many of the other symptoms, it has been already observed, that a large proportion of these appear to be mere consequences of the increased flow of urine and the extraordinary drainage thus produced from the body of what may be deemed necessary to its support, and hence may be presumed to cease spontaneously when the quantity of the urine is rendered natural.

In cases of recent occurrence, and of an acute character, there cannot be a doubt about the propriety and even necessity of general blood-letting, which may be repeated, as often as the circumstances of the case may seem to require. In very protracted cases, however, occurring in old subjects, and, indeed, wherever the debility is excessive, this remedy can be seldom required; though even in such cases it has been shown that blood-letting can be borne much better than could be expected. In most cases also frequent local bleeding from the epigastric region has been found beneficial, particularly when an extraordinary sense of fulness, heat, or tenderness has been experienced about the stomach. The bowels should be kept freely open by some gentle aperient, and, perhaps, there is none better suited for this purpose than castor oil. All saline and other purgatives likely to act as diuretics should in general be avoided, as should mercury, which seems capable of doing much mischief in this disease, more especially when pushed to any extent.*

To counteract that nervous irritability so distressing in this affection, the use of some sedative, and more especially opium, seems to be indicated; and of all the preparations of opium the *pulvis ipecacuanhæ compositus*, from its well-known property of determining to the skin, appears to me to be the best suited to the purpose.† The dose of this of course must be regulated according to circumstances, but in few cases more than from, gr. v. to ℈j three times a day will be required, and very often much less than this will serve all useful purposes. In cases of an acute character the use of opium should always follow blood-letting, without which precaution it may do more harm than good. In cases of a chronic character, and accompanied by much debility and nervous irritation, I have seen the very best effects produced by a combination of the preparation of opium above-mentioned, and full doses of the *carbonas ferri*, exhibited in the form of an electuary, made with the *albumen ovi*. In such cases, as the patient recovers, the quantity of the sedative may be gradually diminished, while that of the tonic (provided nothing contra-indicates its use) may be increased. The sul-

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* I wish not to be misunderstood in these points. The occasional use of saline and mercurial remedies directed to the bowels or skin may be proper, and even beneficial in some instances, particularly when the disease has been a little subdued. It is the too free employment of these remedies, and more especially of mercury, that I feel disposed to call in question. When mercurial alteratives are necessary the *hydrarg. cum cretâ* seems to be the best adapted to the purpose.

† In the first edition of this work I gave an abstract of four cases, treated by Dr. Elliotson, at St. Thomas's Hospital, chiefly by opium. In these cases the effects of this remedy on the urine were accurately noticed, and were such as to place be-

yond a doubt its good effects in diminishing the quantity of urine, and relieving many of the distressing symptoms apparently depending on this circumstance. At the same time I am sorry to say, that the event showed that opium, however freely administered, is not capable of permanently curing the disease; and when we reflect, that thus freely administered its effects may become as formidable as those of the disease itself, we certainly feel very little encouragement to push this remedy to an inordinate extent. Subsequent experience has indeed satisfied me, that all the beneficial effects to be really expected from opium, may, in most instances, be obtained by moderate doses only; and when thus judiciously exhibited, and when no peculiarity of constitution forbids its use, I believe that it will be found to constitute one of the most powerful remedies that we possess in this disease. Those who wish to refer to Dr. Elliotson's cases will find them in his work on Prussic Acid, &c. above quoted, p. 89.

phate of Quinina has also been lately said to prove particularly beneficial in this state of the affection.

In conjunction with the above remedies, and with a view of restoring the cutaneous functions, the warm or vapour bath, the flesh brush, &c. may be freely employed, and the patient should also, with the same view, wear flannel next the skin, and while thus warmly clothed, take all those exercises which his debilitated state will permit, without producing too much fatigue. Dr. Marsh has particularly insisted on the good effects of these means, and I admit that in certain stages of the disease their efficacy is very great.* They must, however, be employed with some caution in the acute states of the affection, and also when there is very great debility; as in the former case they appear to increase the general irritation, and in the latter to produce such a degree of exhaustion as to lead to syncope, a tendency to which I have seen produced by the least exercise in a protracted case attended with much debility. It may be remarked, however, that in this case, after the patient became better under the plan above-mentioned, he could not only take considerable exercise with impunity, but with advantage.

But of all other means, attention to diet and regimen seems to be of the most importance in the treatment of diabetes. In the first place, as connected with this part of the subject, the quantity of fluid to be taken by the patient must be considered. That this should be as limited as possible there can be no doubt; for if he be permitted to drink *ad libitum*, we can scarcely hope for benefit from any remedy. There is generally, indeed, such a degree of mental imbecility, or want of stoicism on the part of the patient, that it is often very difficult to get this point properly attended to, and he will even frequently drink by stealth, when he cannot for shame or want of opportunity do it openly. Indulged to a certain extent he must and ought to be, and hence it becomes necessary to consider those drinks of which the least quantity is likely to be taken by the patient, and from which at the same time least harm may be probably expected.

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* Ubi supra.

The Bristol Hotwell, and other waters, containing carbonate of lime in solution, have been long celebrated in diabetic affections; and, as Dr. Marsh has observed, they appear to quench the thirst in these complaints better than most other drinks.* How they act, or whether they really do exert a beneficial effect, I am unable to say; but certainly small doses of carbonate of lime and of magnesia, which were probably first recommended on the faith of the beneficial action of the above waters, do occasionally seem to exert a temporary good effect in diabetes, by diminishing the thirst, and through this medium, the quantity of drink and urine. Notwithstanding this, however, I cannot help thinking that both principle and analogy require that the purest waters, even distilled water, should be employed in preference in this affection; and that such waters agree well I have evidence from experience. Besides water, various animal decoctions, milk, &c. may be taken, and in cases of great debility, and where the patient has been accustomed to the use of fermented liquors, a little weak brandy and water may be allowed. As general rules also connected with this subject, it may be observed, that all drinks should be taken in a *tepid* state, as the patient, whose craving is generally after *cold* drinks, will thus content himself with less: and, secondly, They should be taken at those periods, in preference to others, when the stomach is not loaded with solid food.

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* I have known a patient labouring under confirmed diabetes drink very largely of the Leamington saline waters without increasing the quantity of his urine, and even apparently with some advantage to his general health; yet no one, I presume, would think of recommending these waters as a means of cure in this affection. Indeed the good effects, if any, of the substances mentioned in the text, as well as those attributed to the phosphate of soda, and other saline matters lately recommended, are very difficult to be explained, except upon some general principle, of no very obvious nature; for it is hardly possible to conceive that so many different substances can each exert a specific operation on the disease.

For some years past the use of a diet exclusively animal has been much insisted on in this affection, and I agree with this so far as to think that the diet of the diabetic patient should consist essentially of animal and farinaceous matters, and that he should abstain as much as possible from sweet and acescent matters, as fruits, &c. When I state this, however, I beg leave to say, that it is not upon any hypothetical principles, but simply upon grounds I believe universally admitted, namely, that animal and farinaceous matters are more easily digested and assimilated than others.* A point to be attended to of fully as much importance as the quality of diet is its *quantity*. The constant craving for food in this disease generally induces the patient to take by far too much at one time, the consequences of which are not only unfavourable to his recovery, but sometimes dangerous and even fatal; indeed, I believe the greater number of cases of sudden death in this affection (which is by no means an uncommon termination of it), have been distinctly referrible to errors either in the quality or quantity of the food, or both; that is to say, the patient has been generally cut off after a *hearty meal,* as it is vulgarly termed. As a general rule with respect to diet, I should say, that a quantity greater or less, according to circumstances, but always *strictly regulated,* should be taken at periods of four, five, or six hours; and that at the time of taking solid food, and for an hour or two afterwards, all drink should be abstained from as much as possible. Were I to particularize the species of food, I should say generally, that mutton or beef, plainly cooked, and particularly mutton-chops or beef-steaks, rarely done, should be taken twice in the twenty-four hours, and that the other meals should consist of any simple article that can be prepared from farinaceous matters with milk, eggs, &c. only.

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* I have watched the effects of an exclusively animal diet on the urine of diabetic patients. In most instances it seems to lessen the quantity, and deepen the colour of the urine, and thus to *disguise* the saccharine matter present; but as far as I have been able to ascertain, it does not diminish the specific gravity of this secretion. I think also with Dr. Marsh, that an unlimited allowance of animal food is calculated to do much harm in some instances, and agree with him, that the diet should always consist, in part at least, of vegetable, and particularly of farinaceous matters, as mentioned in the text. Indeed, if the patient conforms upon the whole to the prescribed regimen, I see no objection to his being allowed occasionally other vegetable matters, as fruit, &c. *in very small quantity*. When I make this statement, however, I hope not to be misunderstood. There is no doubt that a diet exclusively vegetable, and particularly consisting of large quantities of sweet or acescent matters, is liable to do a great deal of mischief in this disease.

The above plan of diet is, perhaps, applicable in all cases of diabetes. In particular instances, however, when the appetite and thirst have been very inordinate, it may be prudent at first to diminish the quantity of both solids and fluids gradually. The patient will thus be not only more likely to fall into the proposed plan; but the serious consequences which have been known to follow a sudden and great diminution in the quantity of matter taken into the stomach, will be prevented. In the latter and chronic stages of the disease, also, animal food may be generally taken much more freely and with greater advantage, than in the early and acute state of the affection.

Lastly, it is of the utmost importance in this affection, that the mind should be set at rest. Nothing retards the cure so much as mental anxiety of every description. Indeed if this point cannot be effected, very little relief can, I fear, be expected from any treatment whatever.

By attention to these rules, I cannot help thinking, from what I have seen, that as much benefit as can be rationally hoped for in this disease, may be generally obtained. Under such a plan, even but imperfectly followed up, I have seen the urine become natural in quantity, the skin moist, the unnatural thirst and appetite, in short, almost all the unpleasant symptoms, either very much mitigated or removed, and the patient thus rendered so well as to be able to resume his usual pursuits, when not of too laborious a character. I do not mean to say, that the patient has been completely cured, for the specific gravity of the urine has generally continued much above the healthy standard, thus unequivocally demonstrating the presence of saccharine matter; and this I have every reason to believe has been the case in all those instances in which a cure has been pretended to be effected.*

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* Within the last six or seven years nearly twenty cases of this disease have fallen more or less under my observation; and among these I have never but in *one* instance, and in that *for a very short time only*, seen the urine of a diabetic patient rendered quite natural. It has been mentioned in the preceding pages, that an excess of urea frequently precedes the appearance of saccharine matter in the urine; now it is a remarkable fact, that in diabetes

A long and steady perseverance in the above rules is absolutely necessary to ensure their good effects; and under such circumstances, though I have never happened to see an instance of it, I am willing to believe, that in favourable cases the urine *may* at length become quite natural and remain so, and thus a permanent cure be effected.

in proportion as the saccharine matter diminishes under the above plan, that of urea generally increases; and in such instances the presence of the former principle can not only be no longer distinguished by the sensible properties of the urine, but scarcely be demonstrated by the utmost skill of the most experienced chemist, though the specific gravity of the urine may at the same time be nearly 1·040. I have recently been favoured by Dr. Elliotson with the most complete and remarkable change of this description that has yet occurred to me. The patient, besides being diabetic, was in the last stage of phthisis, of which he died shortly afterwards. The quantity of urine past daily, when I first examined it, was six or eight pints; its specific gravity was 1·038, and it contained a large proportion of very white sugar and very little urea. Dr. Elliotson under these circumstances gave opium, beginning with gr. i, and increasing the dose to gr. iii, thrice a day. The opium produced stupor, and was obliged to be discontinued, but the effects produced upon the urine by its means were most remarkable. *In about* 60 *hours the quantity of urine was diminished to two pints, its specific gravity was reduced to* 1·0174, *the saccharine matter had apparently disappeared, and was superseded by urea, the quantity of which had become excessive.* This alternation of a principle containing nearly half its weight of azote, with another containing no azote at all, is, perhaps, one of the most singular facts occurring in physiology.

b. ON THE DISEASES OF THE URINE IN WHICH PRINCIPLES INSOLUBLE IN THAT SECRETION ARE MORBIDLY DERANGED IN QUANTITY OR QUALITY.

CHAP. IV.

Description of Urinary Gravel and Calculi, with a summary Account of their Chemical Composition, &c.

MECHANICAL deposites from the urine, though composed of the same general ingredients, may, in a pathological point of view, be conveniently divided into three classes—I. Pulverulent, or amorphous sediments; II. Crystallized sediments, usually denominated gravel; and, III. Solid concretions, or calculi formed by the aggregation of these sediments.

I. *Pulverulent or amorphous sediments.* These sediments almost universally exist in a state of solution in the urine before it is discharged, and even afterwards till it begins to cool, when they are deposited in the state of a fine powder, the particles of which do not appear to be crystallized. Their general appearance is very various, though their colour, for the most part, is red, diluted with more or less of brown or yellow. Their composition is as various as their colour; and they may be said to contain, at different times, almost every principle capable of becoming solid itself, or of forming a solid compound with any other principle found in the urine. Generally speaking, however, they may be stated to consist of two species of neutral saline compounds, viz. the lithates of ammonia, soda, and lime, tinged more or less with the colouring principle of the urine, and with the purpurates of the same bases, and constituting what are usually denominated *lateritious* and *pink* sediments; and, secondly, the earthy phosphates, namely, the phosphate of lime, and the triple phosphate of magnesia and ammonia, constituting for the most part sediments nearly white. These two species of sediments very frequently occur mixed together, though the lithates generally prevail; and it is to this circumstance, and to the little tendency that the salts of which they are composed have to assume the crystallized form, that their heterogeneous and amorphous nature is to be referred.

II. *Crystallized sediments, or gravel.* This class of sediments is commonly voided in the form of minute angular grains, or crystals mechanically diffused through the urine, and which subside almost immediately to the bottom of the vessel in which it is contained. In such cases, which may be considered of an extreme kind, an additional quantity of crystals is usually deposited as the urine cools.

In slighter cases, few or perhaps no crystals are voided with the urine; but they are deposited abundantly upon its surface, and upon the sides of the vessel in which it has stood for some hours. These crystals are composed of—1. Lithic acid nearly pure;* 2. The triple phosphate of magnesia and ammonia; and, 3. Oxalate of lime.

The crystals of lithic acid, which are by far the most frequent, are always more or less of a red colour. Those composed of the triple phosphate of magnesia and ammonia are always white; while those composed of the oxalate of lime, which are extremely rare, are of a dark blackish green colour.

It may be remarked, that these different varieties of crystallized deposites are *never voided together* in the same urine, though the two former not unfrequently occur mixed with amorphous sediments, and even with one another, after the urine has stood some time.

The nature of these sediments may be ascertained by the means to be presently pointed out under the head of calculi composed of similar substances.

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* I have said *nearly pure* because they always contain colouring matter, &c. Berzelius, indeed, states that they consist of the *super-lithate* of ammonia; and it is true that they not unfrequently give off a little ammonia when dissolved in a solution of potash: but whether the ammonia be in actual combination with the lithic acid, or whether it be derived from a small proportion of the common lithate or purpurate of ammonia, with which they may be contaminated, I have been unable to ascertain. I incline at present to the latter opinion.

III. *Solid concretions, or urinary calculi.* From various causes, to be explained hereafter, the before-mentioned sediments concrete together into solid masses, forming what are well known under the name of urinary calculi. These vary much in their appearances and chemical composition, as the following summary description of them will show:

The species of calculi already known are,

1. *The lithic acid calculus.*
2. *The lithate of ammonia calculus.*
3. *The oxalate of lime, or mulberry calculus.*
4. *The cystic oxide calculus.*
5. *The bone earth, or phosphate of lime calculus?*
6. *The triple phosphate of magnesia and ammonia calculus.*
7. *The calculus composed of a mixture of the phosphate of lime and triple phosphate of magnesia and ammonia, or the fusible calculus.*
8. *The alternating calculus.*
9. *The mixed calculus.*
10. *The carbonate of lime calculus.*
11. *The xanthic oxide calculus.*
12. *The fibrinous calculus.*
13. *The prostate calculus.*

1. *The lithic acid calculus* is generally of a brownish red or fawn colour, but occasionally of a colour approaching to that of mahogany. Its surface is commonly smooth, but sometimes finely tubercu-

lated; and upon being cut through, it is usually found to consist of concentric laminæ. Its fracture generally exhibits an imperfectly crystallized texture, sometimes an amorphous or earthy one, in which case it usually contains a mixture of other substances. This is one of the most common species of calculi.—*Chemical characters.* Before the blow-pipe this calculus blackens, emits a smoke having a peculiar odour, and is gradually consumed, leaving a minute quantity of white ash, which is generally alkaline. It is completely soluble in caustic potash, and precipitable again by any acid in the form of a white granular powder. Lastly, if to a small particle a drop of nitric acid be added, and heat applied, the lithic acid is dissolved; and if the solution be evaporated to dryness, the residue assumes a beautiful pink or carmine colour.

2. *The lithate of ammonia calculus* is generally of a clay colour. Its surface is sometimes smooth, sometimes tuberculated. It is composed of concentric layers, and its fracture is very fine earthy, resembling that of compact lime-stone. This calculus seems to be principally confined to children under puberty, and hence is generally of small size, and rather uncommon.* The lithate of ammonia very frequently occurs mixed with the oxalate of lime, and even lithic acid, forming a mixed variety of calculus.—*Chemical characters.* This in many

* Med. Chirurg. Trans. vol. x. p. 389.

of its properties closely resembles the last species. Before the blow-pipe, however, it usually decrepitates strongly. It is much more soluble in water than the lithic acid calculus; and always gives off a strong smell of ammonia on being heated with caustic potash. The lithate of ammonia is also readily soluble in the alkaline sub-carbonates, which pure lithic acid is not: and in this case the fixed alkali seems to take the place of the ammonia, while the ammonia combines with the carbonic acid of the sub-carbonate.*

3. *The oxalate of lime, or mulberry calculus,* is generally of a very dark brown colour, approaching to black. Its surface is very rough and tuberculated (hence the epithet of *mulberry*). It is usually hard, and when cut through exhibits an imperfectly laminated texture. This species of calculus seldom sur-

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* Perhaps this fact will enable us to account for the effect said to be produced by alkaline carbonates upon calculi in the bladder, when long persevered in. This opinion is also rendered further probable, by another fact which I have several times noticed where alkaline remedies have been long taken, and where probably amorphous sediments abounded in the urine—namely, that a large proportion of the external white crust of the calculus, which has been supposed in general to consist of the phosphates, has consisted of the lithate of soda or potash (according as the alkaline matter taken has been soda or potash) mixed with a small relative proportion of the phosphates. A similar change also sometimes takes place in the composition of amorphous sediments themselves, from the exhibition of the same remedies. In such cases the change is evidently for the worse, as the lithates of soda and potash are less soluble than the lithate of ammonia.

passes the medium size, and is rather common. There is a variety of it remarkably smooth, and pale coloured. These are always of small size: and from their colour and general appearance, have been termed the *hemp-seed* calculus.*—*Chemical characters.* Before the blow-pipe this species of calculus expands into a kind of white efflorescence, which, when moistened and brought into contact with turmeric paper, stains it red. This white alkaline substance is the caustic lime deprived of its oxalic acid.

4. *The cystic oxide calculus* is of a yellowish white colour, and its surface, which is commonly smooth, exhibits a kind of crystallized appearance. When broken, it is found not to consist of distinct laminæ, but appears as one mass confusedly crystallized throughout its substance. The fracture exhibits a peculiar glistening lustre like that of a body having a high refractive density; and when in small fragments, it is semi-transparent. This calculus is small, or not surpassing the medium size, and is very rare.—*Chemical characters.* This yields a very peculiar and characteristic odour when exposed to the flame of a blow-pipe. It is also very readily soluble both in acids and alkalies.

5. *The bone earth, or phosphate of lime calculus,*

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* This variety seems to contain lithate of ammonia, which principle is found mixed in every proportion with the oxalate of lime; but when the oxalate predominates the calculus frequently assumes the characters noticed in the text.

is generally of a pale brown colour: and its surface is smooth like porcelain, so as to appear highly polished. When sawn through, it is found very regularly laminated, and the laminæ readily separate from one another. These laminæ are striated in a direction perpendicular to the surface, as from an assemblage of fibres. This species of calculus has not hitherto been observed of large or even of medium size, and is extremely rare.*—*Chemical characters.* This does not fuse before the heat of the blow-pipe. It is readily soluble in muriatic acid, and precipitable in the form of a white powder without decomposition.

6. *The triple phosphate of magnesia and ammonia calculus* is always nearly white; its surface is commonly uneven, and covered with minute shining crystals. Its texture is not laminated, and it is easily broken and reduced to powder. In some rare instances, however, it is hard and compact, and when broken, exhibits a crystallized texture, and is more or less transparent. Calculi composed entirely of the triple phosphate of magnesia and ammonia are rare; but specimens in which this salt constitutes the predominant ingredient are by no means uncommon. —*Chemical characters.* Before the heat of the blow-

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* I am exceedingly doubtful if this species of calculus be of urinary origin. Calculi of precisely the appearance and properties here described, I have seen taken in great numbers from an abscess in the prostate gland, where they appear to have been formed. This subject will be further considered when we come to speak of the diseases of that gland.

pipe, this calculus gives off the odour of ammonia, and at length melts with difficulty. It also gives off ammonia when treated with caustic potash. It is much more soluble than the preceding species in dilute acids, from which it is again readily precipitated by ammonia in its original crystallized form.

7. *The calculus composed of a mixture of the phosphate of lime and triple phosphate of magnesia and ammonia, or the fusible calculus,* is commonly whiter and more friable than any other species, resembling sometimes a mass of chalk, and leaving a white dust on the fingers. This species is generally not laminated. Occasionally, however, it separates readily into laminæ, the interstices of which are often studded with sparkling crystals of the triple phosphate. The variety of this species which is not laminated often requires a very large size, and assumes the form of a spongy friable whitish mass, evidently moulded to the contracted cavity of the bladder in which it has been formed. This species of calculus occurs very frequently.—*Chemical characters.* It may be readily distinguished by the ease with which it melts before the blow-pipe. It also dissolves readily in acids, and particularly in dilute muriatic acid; and if to the solution oxalate of ammonia be added, the lime is precipitated alone, and the magnesia may be afterwards separated by the addition of pure ammonia.

8. *The alternating calculus,* as the name imports, may consist of different layers of any of the preceding

species. Hence its general appearance, texture, &c. will depend entirely on the composition, and may be very varied. Most commonly it is composed of a lithic acid or mulberry nucleus, and an external crust of the fusible calculus. In some rare instances it is composed of laminæ of all three of these substances, and sometimes of even more—the mixed phosphates still continuing to constitute the external crust. This species of calculus often acquires a very large size, and is very common.—*Chemical characters.* The chemical characters must of course vary with the composition; and as the different substances of which it is composed must almost certainly be some of the preceding, the nature of the different laminæ can be readily ascertained by what has been already stated.

9. *Mixed calculi* consist of an intimate mixture of any two or more of the preceding species; but generally of a mixture of the lithate of ammonia and the phosphates.* Their colour of course varies with their composition; but is commonly indeterminate. They are for the most part not laminated, and possess considerable hardness. They have been seldom seen of large size, and fortunately are very

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* There is obviously a strong chemical objection to the opinion that uncombined lithic acid and the phosphates can be precipitated from the urine at the same time, though the circumstance might happen accidentally. Perhaps the variety of calculus above alluded to, consisting of the lithate of ammonia and the oxalate of lime, might with propriety be also referred to the head of *mixed* calculi. See Note, p. 89.

rare.—The *chemical characters* of mixed calculi of course are of an ambiguous nature, and will depend upon their composition. The nature of the different principles entering into their composition may be readily ascertained from what has been already stated.

10. *Carbonate of lime calculus.* I have seen some small calculi composed almost entirely of this salt. They were perfectly white, and very friable. Mr. Smith has described others which closely resembled in appearance the mulberry calculus.* This species of calculus is very uncommon. As to their chemical characters, they are readily detected by their dissolving with effervescence in acids, and other well-known properties.

To these ten species Dr. Marcet has added two others,† namely,

11. *The xanthic oxide calculus,* of which only one specimen seems yet to have been observed; and,

12. *The fibrinous calculus,* apparently composed of the fibrin of the blood. Both these calculi were small, and are probably of very rare occurrence. The former was termed *xanthic* or *yellow oxide,* from its characteristic property of yielding a yellow colour when acted on by nitric acid. The latter was found to possess all the characters of the fibrin of the blood.

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* Med. Chirurg. Trans. vol. xi. p. 14.

† See an Essay on the Chemical History and Medical Treatment of Calculous Disorders, by Alex. Marcet, MD. FRS. &c.

There is another species of calculus which, though not of urinary origin, is very liable to be mistaken for such, from the situation in which it is formed—namely,

18. *The prostate calculus.* Of this there seems to be two varieties. The first variety is usually formed in the natural cavities of the gland before it becomes much disorganised. They are generally small, and more or less rounded in shape, and of a yellowish brown colour. The second variety seems to be generally found in abscesses of that gland, where they are sometimes met with in great numbers. These are usually of a much larger size than the first variety, and have a highly polished porcelainous appearance. The composition, however, of both varieties is essentially the same; that is to say, they consist chiefly of the phosphate of lime; * a substance which appears to be never deposited in an unmixed state by the urine. Hence prostatal calculi can always be readily distinguished from those of urinary origin. See Note, p. 90.

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* The proportion of the phosphoric acid seems to vary in these calculi in different instances.

CHAP. V.

Data showing the Comparative Prevalency of the different Forms of Urinary Deposite, and the Order of their Succession. Observations founded upon these Data, illustrative of the General Pathology of Calculous Affections, &c.

In treating of this part of my subject, I shall avail myself of the data published by preceding authors; which data I shall, in the first place, lay before my readers, in the order of time in which they have appeared.

The first collection of calculi, of which an examination was made, adapted to my present purpose, was that in the Hunterian Museum. The examination was made by Mr. Brande. According to this gentleman, of 150 calculi, the following were the relative proportions of each species:

Of lithic acid, nearly pure	16	61
Of lithic acid mixed with a small relative proportion of the phosphates	45	
Of oxalate of lime, chiefly		6
Of the phosphates, nearly pure	12	78
Of the phosphates mixed with a small relative proportion of lithic acid	66	
Of lithic acid and the phosphates with nuclei of oxalate of lime		5
		150*

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* Philos. Trans. xcviii. 223.

The next tables I shall quote are from Dr. Marcet's work. Of 181 specimens taken by that gentleman, indiscriminately, from the extensive collection at Norwich, the following are stated to be the relative proportions of each:

Of lithic acid, in which the character was well defined,			66
Of oxalate of lime chiefly			41
Of the phosphate of lime, nearly pure		4	53
Of the phosphate of lime and triple phosphate, constituting the fusible calculi		49	
Alternating calculi composed of....	Lithic and mulberry	15	19
	Mulberry and triple	1	
	Fusible and lithic	1	
	Fusible and mulberry	2	
Mixed or compound calculi			2
			181*

In the collection of Guy's Hospital, consisting of 87, the following are the relative proportions according to the same gentleman:

Of lithic acid, nearly pure	16	22
Of lithic acid mixed with a little oxalate of lime..	6	
Of oxalate of lime		22
Cystic oxide		1
Of the phosphate of lime, nearly pure	3	29
Of the triple phosphate	2	
Of the mixed phosphates or fusible calculi	24	
Alternating calculi		6
Mixed or compound calculi		7
		87†

Of 187 calculi, constituting the aggregate of the different collections of various gentlemen in Manchester and its neighbourhood, the following are the relative proportions, according to Dr. Henry:

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* P. 107, first edition.

† Loc. cit.

Of lithic acid chiefly			71
Of oxalate of lime			11
Of cystic oxide			2
Of the phosphates pure, and constituting the entire calculus		4	22
Of the phosphates less pure, mixed with lithic acid, &c.		18	
Alternating calculi composed of	Lithic acid and phosphates	39	73
	Oxalate of lime and phosphates	16	
	Oxalate of lime and lithic acid	11	
	Oxalate of lime, lithic acid, and phosphates	7	
Mixed or compound calculi			8
			187*

Mr. R. Smith, of Bristol, in a very excellent paper on the subject of calculi, entitled "A Statistical Inquiry into the Frequency of Stone in the Bladder, in Great Britain and Ireland,"† has given the following table of the calculi preserved in the collection of the Bristol Infirmary. The collection, exclusively of those formed on foreign substances, consists of 218 specimens from the human bladder.

Of lithic acid, nearly pure			74
Of oxalate of lime, nearly pure			33
Of the phosphate of lime, nearly pure		1	20
Of the ammoniaco-magnesian phosphate		1	
Of the fusible calculi, or mixed phosphates		18	
Alternating calculi.	Oxalate of lime and lithic acid	29	83
	Lithic acid and phosphates	12	
	Oxalate of lime and phosphates	32	
	Composition not all mentioned	10	
Mixed or compound calculi			8
			218

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* Med. Chirurg. Trans. x. p. 127. † Ibid. xi. p. 1.

Table exhibiting a general view of the preceding data.

General character.	Particular Species.	Hunterian Museum, Mr. Brande.	Norwich, Dr. Marcet.	Guy's Hospital, Dr. Marcet.	Manchester, Dr. Henry.	Bristol, Mr. Smith.	Particular Totals.	General Totals.
Lithic acid	Nearly pure	16	66	16	71	74	98	294
	Mixed with a little oxalate of lime	—	—	6			6	
	Mixed with a little of the phosphates	45	—	—			45	
Mulberry	or oxalate of lime....	6	41	22	11	33	113	113
Cystic oxide ..	—	—	—	1	2	—	3	3
Phosphates	Nearly pure	12	—	—	4	—	16	202
	Mixed with a small proportion of the lithic acid	66	—	—	18	—	84	
	Phosphate of lime nearly pure.....	—	4	3	—	1	8	
	Triple phosphate, nearly pure.....	—	—	2	—	1	3	
	Fusible, or mixed calculi	—	49	24	—	18	91	
Alternating Calculi	Lithic and mulberry	—	15	—	—	—	15	186
	Mulberry and lithic	—	—	—	11	29	40	
	Lithic and phosphates..........	—	—	—	39	12	51	
	Mulberry and phosphates	—	1	—	16	32	49	
	Lithic, mulberry, and phosphates..	—	—	—	—	—	—	
	Mulberry, lithic, and phosphates	5	—	—	7	—	12	
	Fusible and lithic....	—	1	—	—	—	1	
	Fusible and mulberry	—	2	—	—	—	2	
	Composition not mentioned.....	—	—	6	—	10	16	
Mixed or Compound Calculi	Mixture not mentioned......... .	—	2	7	8	8	25	25
		150	181	87	187	218		823

In the preceding table, the whole of the data are collected into one point of view, under the general titles of *lithic acid, mulberry, cystic oxide, phos-*

phates, *alternating* and *compound calculi;* each of which we shall now proceed to consider in detail.

1. *Lithic acid calculi.* Under this head are classed all those calculi in which this principle evidently predominates, and the general table indicates that somewhat more than $\frac{1}{3}$ of the whole number belongs to this class, a proportion that holds good likewise of each of the individual collections, except that at Guy's Hospital, where the proportion is only one-fourth.

But if we take into consideration the fact universally admitted by all authors upon this subject, that lithic acid constitutes by far the most common nucleus round which other calculous matter is subsequently deposited, we may, I think, safely assert, that at least *two-thirds* of the whole number of calculi originate from lithic acid; that is to say, if a lithic acid nucleus had not been formed and detained in the bladder, two persons at least out of three who suffer from calculus would have never been troubled with that affection. This is a most important fact, and deserves to be constantly borne in mind.

It has been stated in the preceding chapter, that the urinary sediments in which the lithic acid predominates are of two descriptions, *amorphous* and *crystallized*, and that the amorphous consists chiefly of the lithate of ammonia, and the crystallized of lithic acid nearly pure; now this distinction appears to me to hold good with respect to lithic acid calculi some being composed of the amorphous sediments and some of the crystallized, but by far the greater number of a mixture of the two. It is with the greatest deference that I presume to differ from the eminent chemists who have preceded me in this field, but I am reluctantly compelled to do so on the present occasion. I have elsewhere shown, that calculi exist composed almost entirely of the lithate of ammonia, and I think it may be asserted that all lithic calculi which have an amorphous or earthy fracture, contain more or less of the same compound. Even the most superficial observer must have remarked, that lithic calculi differ exceedingly in their sensible properties; that some are of a deep fawn colour, distinctly laminated, and exhibit a perfectly *crystallized* fracture; that in others these characters are less distinct, or sometimes entirely disappear; the colour being pale brown, or clay-like, and the fracture perfectly earthy, or amorphous. Every one, I repeat, must have remarked this circumstance, and the natural inference appears to be that the red crystallized calculus is composed of the red crystallized gravel, and the earthy amorphous one, of the amorphous sediments; and this inference seems to be justified by experiment; the crystallized calculus being, according to my experiments, composed of nearly pure lithic acid; and the amorphous one of lithic acid, more or less of ammonia, generally a little of the phosphates, and sometimes a small portion of the oxalate of lime.

The lighter the colour, the greater in general the proportion of lithate of ammonia and the phosphates.

The data in our possession do not enable us to determine the comparative prevalency of these varieties of lithic calculi; but, according to my own observations, those composed of a mixture of the crystallized and amorphous sediments are the most common; while the well-marked crystallized variety is comparatively more rare; and the third variety, or those composed of pure lithate of ammonia, are still more uncommon. The most perfectly crystallized variety, I think, is to be generally found among the largest specimens; a circumstance, perhaps, that will not appear difficult to be explained hereafter.

2. *Oxalate of lime, or mulberry calculi.* On comparing the general totals in the preceding tables, it will be found that the mulberry calculi constitute rather less than $\frac{1}{7}$ of the whole number. The proportion, however, differs exceedingly from this and from one another in the different collections. Thus of the 150 calculi examined by Mr. Brande, only six were composed of the oxalate of lime, or $\frac{1}{25}$ of the whole; and even the most pure of these are stated to contain as much as 35 per cent. of other matter; he accordingly remarks that he had rarely met with it. In the Norwich collection, on the contrary, nearly $\frac{1}{4}$; and in the collection at Guy's, even somewhat more than this, according to Dr. Marcet, are of the mulberry species. In the Manchester collection only $\frac{1}{17}$ consists of oxalate of lime, nearly

pure; but if we take into account all those that contain this substance, the proportion will be found to constitute about $\frac{1}{4}$ of the whole collection, as in those of the Norwich and Guy's Hospital. In the Bristol collection rather less than $\frac{1}{6}$ of the whole consists of oxalate of lime, nearly pure; but if all be included, containing that salt, $\frac{5}{12}$, or nearly *one half* of the whole, will belong to this class! Thus it appears, that in the district of which Bristol may be considered as the centre, this species of urinary deposite is far more frequent than any other, and much exceeds its usual relative proportions, as observed in other parts of the kingdom. The infrequency of this species of calculus in the Hunterian collection, constitutes an anomaly that appears at present inexplicable.

3. *Cystic oxide calculi.* The rarity of this species of calculus is such, that only 1 in 274 appears from the data before us, to be of this description; and I think it not improbable that even this estimate is greater than the truth; since three out of the five collections contain no specimen of it.

4. *Calculi composed of the phosphates.* From the data in our table it will appear that about $\frac{1}{4}$ of the whole number of calculi consist of the phosphates, and that half of this proportion, or about $\frac{1}{8}$, consists of the mixed phosphates. But, whoever has paid much attention to the subject of urinary calculi, will perceive that these estimates are very incorrect, especially as far as regards the proportion of the

calculi composed of the mixed to those composed of the pure phosphates. It may be observed also, that calculi have frequently the appearance externally of being composed of the phosphates, while they contain a nucleus of a very different substance: except, therefore, calculi are sawn through the centre, it is impossible to ascertain their composition where the phosphates are concerned. Now, in the above data all the calculi, except some examined by Dr. Marcet, at Norwich, appear to have been sawn through;* there cannot, therefore, be much inaccuracy from that cause; yet great confusion arises respecting the comparative frequency of this species of calculi, from the different methods of examining and arranging them adopted by different authors. Thus, from the method followed by Mr. Brande, it is impossible to infer whether the lithic acid, which he states the calculi he examined to have contained, was derived from lithic acid nuclei, which is most probable, or whether from the whole calculus through which it was equally diffused.† The description of the collection at Norwich does not enable us to draw any inference, with respect to the point in question, from the reasons above given; but in that of Guy's Hospital, no less than 24 out of 87 are stated to belong to the fusible species. Here it is evident that Dr. M. must mean *externally;* for he admits himself elsewhere, in common, I believe, with every other author who has written on the subject, that lithic acid constitutes by far the most frequent nucleus round which the other substances concrete. We may, therefore, I think, fairly infer that a large proportion of those calculi placed by Mr. Brande and Dr. Marcet under the head of the phosphates, have a lithic acid, or oxalate of lime nucleus, and consequently belong to the class of alternating calculi; an inference that will be much corroborated by the Manchester and Bristol collections, where these points appear to have been particularly attended to. Thus, Dr. Henry says, that "*in four instances only out of* 187, *the calculus has been composed throughout of the earthy phosphates,* and in these I have not been able to discover a nucleus of any other substance;" but his table contains 18 more, or 22 in all, composed almost entirely of the phosphates; so in the Bristol collection only 20 are stated to consist principally of the phosphates, without, however, any reference to their nuclei, which, of whatever they may consist, we may infer, from the principles of arrangement adopted by Mr. Smith, to be very small. From these observations, then, I think we are entitled to conclude, that the proportion of calculi composed essentially of the phosphates is much less than what it appears to be from the data above given taken collectively, and that those composed *entirely* of the phosphates bear even a very small proportion to those composed principally of them: and this inference fully accords with my own observations on the subject.

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* Dr. M. expressly states that some in the Norwich collection were not cut through: but he is silent on this point with respect to the collection at Guy's. The calculi of the other collections are stated by the authors to have been divided.

† Mr. Brande informs us, that "To injure these calculi as little as possible, they were carefully cut through with a fine saw, and a portion of the whole cut surface removed by a file. In this way all the different ingredients of the calculi were obtained."

5. *Alternating calculi.* These constitute by far the most interesting and important species of calculi, in a pathological point of view, since they present us with a faithful record of the order of succession of the different diatheses, &c. They, deserve, therefore, to be most carefully studied; and my readers will, I trust, in consequence, excuse me for entering rather minutely into the subject.

From the preceding data taken collectively, it appears that between $\frac{1}{4}$ and $\frac{1}{5}$ of the whole number belong to the class of alternating calculi; but that this is a very erroneous view of the subject, will be obvious to every one, even from a superficial examination of the data themselves. Thus, there appears to be only five calculi in the Hunterian collection which, according to Mr. Brande's table, belong to the class of alternating calculi; in the portion of the Norwich collection examined by Dr. Marcet, only 19, or about $\frac{1}{9}$ of the whole; and in the collection at Guy's Hospital, according to the same gentleman, only six, or about $\frac{1}{14}$ of the whole; while in the Liverpool collection, according to Dr. Henry, there are no less than 73 belonging to this class; and in the Bristol, according to Mr. Smith, 83, or between

$\frac{1}{3}$ and $\frac{1}{2}$ of the whole number. These differences, I have no doubt, chiefly arise from the different manner in which the calculi have been arranged by the respective authors, and not from actual differences, at least so great, in the proportion of alternating calculi; for in every collection which I have seen, the proportion of alternating calculi has been strikingly great. But it would be useless to dwell on this part of my subject any longer: I shall, therefore, proceed to examine the different varieties in detail.

a. Lithic and Mulberry. In the Norwich collection, according to Dr. Marcet, no less than 15, or $\frac{1}{12}$ of the whole number examined by him, consisted of calculi of this description, whereas in neither of the other collections is this variety stated to exist. From the manner in which the results are stated with respect to the Hunterian and Guy's Hospital collections, we are indeed unable to decide whether such a variety exist in them or not; but in the Manchester and Bristol collections, there is evidently no such variety: a circumstance of a very singular nature, and pointing out a most striking difference between the diatheses prevalent in the eastern and western parts of the kingdom. I have dissected, and examined with great care, a calculus composed of lithic acid, oxalate of lime, and afterwards lithic acid again, with the view of ascertaining the nature of the transition from one species to the other. The change appeared to take place almost *ex abrupto*, that is to say, on the surface of the lithic calculus, which was a well-marked crystallized one, there was a very thin layer of a lighter colour composed of lithic acid, lithate of ammonia, and oxalate of lime intermixed, and upon this the oxalate of lime was immediately deposited in the crystallized state. The transition back again from the oxalate of lime to the lithic acid, was still more abrupt, and absolutely without any perceptible intermediate state that I could observe; a plain proof, I presume, that *some time must* have elapsed between the deposition of the different calculous matters. The oxalate of lime in this instance consisted of two distinct laminæ; the internal of which was beautifully crystallized in the form of rays perpendicular to the surface of the calculus, while the external consisted of a congeries of distinct crystals (some of them almost transparent), which rendered the external surface slightly rough and tuberculated.

b. Mulberry and Lithic. It is no less remarkable that this variety of calculus is not stated to exist either in the Hunterian, Norwich, or Guy's Hospital collections, though in the Bristol collection it forms nearly $\frac{1}{7}$ of the whole number, and in the Manchester $\frac{1}{17}$. The transition from the mulberry to the lithic sometimes takes place at once, as in the specimen just described; but occasionally a mixture of the two substances occurs between the pure mulberry and pure lithic.

c. Lithic and Phosphates. This common variety of calculus is not stated to exist either in the Hunterian, Norwich, or Guy's Hospital collections. We can hardly, however, infer from this that it does not occur there, but must suppose that it has been included under other heads. In the Manchester collection it constitutes between $\frac{1}{4}$ and $\frac{1}{5}$ of the whole number, and in the Bristol only about $\frac{1}{18}$, a remarkable and striking difference, on which a few remarks will be made when speaking of the next variety. The usual transition from the lithic acid to the phosphates is most interesting and instructive. If the calculus has originally been of the crystallized variety, the first symptom of change is commonly the disappearance of the crystallized character, and the substitution of the amorphous one in its stead; at the same time the colour becomes paler. These characters gradually increase till the fracture becomes perfectly amorphous, and the colour a pale clay-brown, and very soon after this the phosphates appear to prevail entirely. These changes indicate that the transition from lithic acid to the phosphates takes place through the lithate of ammonia, and that it is accompanied by the disappearance of the usual colouring principle from the urine. It may, however, be remarked that we rarely meet with the above series of changes complete, the perfectly crystallized variety of lithic acid seldom passing to the phosphates; while, on the contrary, the pale amorphous variety frequently passes into the phosphates, or contains them mixed. Sometimes, also, the series of changes occurs in a very limited space.

d. Mulberry and Phosphates. In the Hunterian, Norwich, and Guy's Hospital collections, this variety of calculus hardly appears to occur; while in the Bristol it forms upwards of $\frac{1}{7}$ of the whole, and in the Manchester $\frac{1}{11}$. The striking difference between the Manchester and Bristol collections consists in the great number of the mulberry species in the latter, while in the Manchester collection the lithic species predominates. This is a very curious fact, the origin of which is probably to be traced to some difference in the modes of living between the two districts. The transition from the mulberry to the phosphates is sometimes most interesting and instructive: the following is what I have observed on dissecting and analyzing this variety. The nucleus had the usual appearance and composition of the mulberry calculus. Round this was deposited a substance of a less compact and more friable texture, composed of a large proportion of carbonate of lime, mixed with some oxalate of lime; at a greater distance from the centre, the oxalate of lime entirely disappeared, and its place began to be supplied by the phosphate of lime; the compound here, therefore, consisted chiefly of the carbonate and phosphate of lime. Still further from the centre, the carbonate of lime was much less in quantity, and at length altogether disappeared, and the calculous matter consisted almost entirely of phosphate of lime, with a small proportion of the triple phosphate and animal matter: and of this the bulk of the calculus consisted. It was very difficultly fusible. This calculus was extremely friable, and had been broken to pieces in extracting.

e. Lithic, Mulberry, and Phosphates. It is singular that neither of the collections should be stated to contain a specimen of this variety, which is by no means uncommon. In the seventh plate of Dr. Marcet's work, there is a good figure of a calculus of this description.

f. Mulberry, Lithic, and Phosphates. In the Hunterian collection, five specimens of this variety are stated to exist; in the Manchester seven. We are unable from the data to state whether any specimens exist in the other collections, but there can, I think, be little doubt of the fact. In the Bristol collection there are ten specimens of alternating calculi, the nucleus of all of which is stated to consist of oxalate of lime. One of these specimens is made of four regular deposites, namely, oxalate of lime, lithic acid, oxalate of lime and lithic acid mixed, and externally "ammoniaco-magnesian phosphate of lime," a term of which I am at a loss to comprehend the meaning, except it be intended to signify the mixed phosphates.

g. h. Fusible and Lithic. Fusible and Mulberry. Out of 823 calculi, the aggregate of all the collections, only *three* specimens are stated to exist in which the phosphates have been followed or surrounded by other calculus deposites. Hence it may be laid down as a general law,

THAT IN URINARY CALCULI A DECIDED DEPOSITION OF THE MIXED PHOSPHATES IS NOT FOLLOWED BY OTHER DEPOSITIONS.

To this important law there are certainly very few exceptions; and in all the numerous calculi that have fallen under my own observation, I do not recollect a decided instance of one; for in every case in which there appeared at first sight to be an exception to it, this was found, upon a closer examination, to be more apparent than real. The following is a description of a calculus constituting such an apparent exception.* The nucleus was composed of a loose aggregate of particles, consisting principally of the lithate of ammonia, of a pale brown colour. Round this was deposited a layer of considerable thickness, composed almost entirely of the same substance, but hard and compact; without this was deposited an imperfect lamina of the triple phosphate of magnesia and ammonia; and beyond this, several thin and irregular laminæ of the lithate of ammonia and triple phosphate, intimately intermixed with one another: lastly, the whole was covered by a layer of the triple phosphate of magnesia and ammonia, perfectly white, and of a crystallized texture, and consequently nearly pure. Hence this hardly constituted an exception to the general law; for, as will be hereafter shown, the lithate of ammonia seems to constitute, as it were, the intermediate link between the lithic acid and phosphates.*

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* Besides the instance here mentioned, perhaps some of the exceptions to this law might have arisen from the escape into the bladder of a small prostate calculus, which, there acting as a nucleus, became surrounded with lithic acid. I have never known an actual instance of this, but I have seen a case in which prostate calculi have got into the bladder, and in which the urine was at the same time acid; and consequently if the urine had contained an excess of lithic acid, which might have been the case, this would have been deposited on the prostate calculi, and thus formed an apparent exception to the law above mentioned.

Besides these varieties of alternating calculi, it is obvious that many others *may* exist, and probably do so. Indeed there are descriptions of such calculi on record. Thus, Dr. Marcet gives a figure of a small one, composed of lithic acid in the centre, bone earth next, then oxalate of lime, and lastly, the mixed phosphates.† Such varieties, however, are rare, and may be rather considered as curiosities than otherwise important.

6. *Compound calculi.* Calculi termed compound, from being composed of different ingredients mixed up together, are comparatively rare. From the aggregate of the preceding data, it appears that about $\frac{1}{31}$ of the whole number only is of this description.

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* This calculus was the second taken from a young gentleman; the first of which consisted principally of the lithate of ammonia, and whose case is alluded to in a paper published by me on this species of calculus. See Med. Chirurg. Trans. x. p. 389.

† See plate viii. fig. 8, of his work on calculous complaints. In the individual from whom this calculus was taken there was probably an abscess in the prostate gland, into which the original lithic nucleus made its way, and after remaining there some time, and becoming coated with a stratum of phosphate of lime, again made its way back to the bladder.

But the proportion in the collection of Guy's Hospital, is no less than nearly $\frac{1}{12}$, while in the Norwich it is only $\frac{1}{60}$, a prodigious difference, for which there is no apparent reason. It is to be regretted also, that neither of the authors has informed us of what these compound calculi are composed. Are they composed of the same mixture, or of different ones? The answer would be most important, as it would show us what different diatheses can exist together at the same time, and thus, perhaps, throw more light on those affections in general after alternating calculi, than almost any other facts connected with this interesting and important subject. For my own part, I have nothing from my own experience to offer on this head. I have never seen, or rather examined, what I should denominate a compound calculus. I have indeed observed, in the transition stages of calculi, an intervening portion composed of a mixture of the old and the new layers; but this in general has constituted a very small proportion of the entire calculus. Such mixtures have consisted, for example, of the lithate of ammonia and the oxalate of lime; of the oxalate, carbonate, and phosphate of lime; of the lithate of ammonia, and the mixed phosphates, &c. as above-mentioned; but never of pure lithic acid with any other ingredient, and particularly with the phosphates; nor do I believe such a compound ever existed in nature.

Such is a summary account of the various forms assumed by urinary deposites and of their comparative frequency. The reader, however, will readily perceive that, although so different in their composition and appearance, they may in fact be considered as made up of four elementary substances only, viz.

1. *The lithic acid and its compounds.*
2. *The oxalate of lime.*
3. *The cystic oxide: and,*
4. *The earthy phosphates;*

two or more of which principles are seldom or never found in excess in the urine at the same time. Hence they may be supposed to represent so many distinct diatheses, or conditions of the system requiring to be separately considered; and this accordingly is the principle on which the future arrangement of my subject will be founded. The preceding order has been adopted for the following reasons: The lithic acid justly claims to be considered in the first place, not only because it constitutes the most frequent constituent of calculi, but is that also which most generally gives origin to the other species, by furnishing a nucleus round which the matters composing them may concrete. Next to the lithic acid, the oxalate of lime species of calculus seems to possess most strongly the characters of an original diathesis, from the frequency with which it gives origin to renal nuclei. The cystic oxide is extremely rare; but, it seems to originate most frequently in the kidney, and moreover has the property when present of excluding other diatheses. The phosphates naturally fall to be considered in the last place, from the circumstance that they very rarely constitute entire calculi, but *succeed* to the other diatheses, and are themselves very rarely if ever succeeded by any other diathesis.*

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* In a paper by Sir Gilbert Blane, in the second volume of the Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge, published in 1811, are the following remarks, which I think it but justice to the author to publish: "All the substances found in the composition of stone, except the uric acid, of which there is a certain proportion in the most healthy urine, seem to be the creatures of morbid irritation. In almost every instance the concretions of uric acid form the nucleus of stones, which would not be the case if the other substances were produced independently of irritation from the stone itself. The specific effect of this irritation, as the stone advances in size, is to produce, by exciting morbid irritation, the various other compounds which have been enumerated, and there seems to be particular stages of its growth, at which it produces one compound rather than another, as appears by the strata of urinary stones. The several strata may be considered as expressions of this fluctuating action, so as to be registers as it were, of the duration and succession of these actions, in producing the several species of matter composing stratified stones." This paper and another on a similar subject have been recently republished by the author, in a work entitled, "Select Dissertations on several Subjects of Medical Science," p. 182. When the first edition of the present volume was printed, I was not aware of the above view of Sir Gilbert on the subject, or I should have noticed it—a view which, if it had been followed up by the author, would have led him to the discovery of the important law mentioned in the text.

CHAP. VI.

Of the Lithic Acid Diathesis in general, and on the best Means of counteracting it, so as to prevent the Formation of Calculus, or its Recurrence after an Operation.

It has been before stated, that lithic acid is separated from the urine under two distinct forms; first, as an amorphous, or uncrystallized sediment, in which it is always in some state of combination; and, secondly, in a crystallized form, and nearly pure. These circumstances naturally induce us to consider the subject under two points of view; and,

I. *Of amorphous sediments.* The amorphous sediments at present under consideration consist essentially, as has been before stated, of lithic acid in combination with some base, generally *ammonia.* In healthy urine this compound exists in such a proportion, as to be held in permanent solution at all ordinary temperatures. From particular causes, however, affecting the health, the quantity of lithate of ammonia in the urine is liable to be so much increased as to be incapable of being retained in solution at the ordinary temperature of the atmosphere; hence as the urine cools a part of it is deposited, and thus constitutes the sediments in question. Such is an explanation of the phenomenon in its general and most simple form; and the obvious conclusion to be drawn from it is, that the deposition of amorphous sediments is indicative of an *excess* of lithic acid in the urine.*

In considering the causes producing this excess of lithic acid in the urine, perhaps I cannot do better than enumerate the circumstances (excluding, of course, actual disease) which have been observed to produce these sediments in a person subject to slight dyspepsia, but in other respects healthy, and who, consequently, from his susceptibility to the operation of the exciting causes, may be considered in the light of a *delicate test* of their presence and action. These exciting causes are of three kinds—*a.* Simple errors in diet; *b.* Unusual or unnatural exercise, either bodily or mental, particularly after eating, and the want of proper exercise at all other times; and, *c.* Debilitating circumstances.

a. Errors in diet may consist either in a simple excess of the usual wholesome articles of food, or in the partaking of food which is unwholesome, or which uniformly disagrees with an individual. With respect to an excess of wholesome food, it has been observed, first, that all other circumstances being the same, an unusually heavy meal especially of animal food or of bread, is *invariably* followed by a deposition of the lithate of ammonia from the urine. Secondly, that the circumstances of quantity and quality of food being the same as usual, an abrupt or decided change in the time of partaking of it, such, for example, as dining at noon, or eating supper (to which the person is not accustomed), will very frequently produce the same effect: and, lastly, that the same effect is occasionally produced by partaking of food to which the person has not been used, though wholesome in itself, and taken at the usual times and in moderate quantity.

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* I wish to state that I have adopted this general view of the subject chiefly from its simplicity and convenience. The deposition of amorphous sediments, for the most part, indicates an *excess* of lithic acid in the urine, but by no means *universally* so; for they appear to be sometimes deposited in consequence of a very slight excess of acid in the urine.

With respect to the *wholesomeness* of food, so much depends upon idiosyncrasy, that this point can only be determined in many instances by actual trial. Whatever agrees with the stomach of an individual, when taken in moderate quantity, may perhaps be presumed to be easily digested, and therefore *wholesome* as far as regards that individual; and the stomachs of different persons are so various and capricious in this respect, that there is scarcely any kind of food but some stomach may be found capable of digesting it. Certain substances, however, are universally acknowledged to be more difficult of digestion than others. These are enumerated by writers on dietetics, and are sufficiently well known. I shall therefore only notice one or two substances which, of all others, have been observed most apt to produce a deposition of the lithate of ammonia: these are animal substances in general, and more especially heavy, unfermented bread, or compact, hard-boiled fat dumplings or puddings.

Under this head, perhaps, may be classed the effects of waters. *Hard* and impure waters have been long supposed to possess a great influence in diseases of the urine, and every day more and more satisfies me of the truth of this opinion. They frequently derange delicate stomachs very considerably; and sometimes have a tendency to produce the present class of sediments, though they generally act by producing the crystallized sediments or gravel in those disposed to them, as will be stated more fully when we come to consider that form of sediment.

b. Unusual or unnatural exercise of the body or mind, particularly after eating, and the want of proper exercise at all other times. It has been observed, that horse exercise is apt to produce a turbid state of the urine, in those who are unaccustomed to it. I have also remarked, that exercise in general, whether bodily or mental, taken immediately after a principal meal, as after dinner, is almost invariably followed by a deposition of the lithate of ammonia from the urine. On the contrary, the want of active exercise after a certain stage of the digestive process has been completed, is very frequently followed by a similar deposition. I have likewise remarked, that even a moderate meal taken after a day spent in close mental application, or complete bodily inactivity, is very frequently succeeded by the same event.

c. Debilitating circumstances. To this class belong a great variety of unconnected events having no principle in common except that, perhaps, of diminishing the vital energies, such as various medicinal substances; certain conditions of the atmosphere; also depressing passions of the mind, inordinate mental or bodily fatigue, long fasting, and a host of others which need not be enumerated; all of which, the quantity and quality of the diet, &c. remaining the same, will frequently occasion the deposition in question from the urine.

Such are the principal circumstances which have been observed to produce these sediments in the urine. It is, I believe, the common opinion, that all such sediments indicate the presence of fever; and when fever occurs in healthy subjects from other causes, it is indeed accompanied by some form or other of these sediments; but whether the circumstances above enumerated always act by exciting real fever in the system is very doubtful, certainly at least such fever is often very slight, and by no means commensurate with the quantity of sediment that frequently appears on such occasions. That the organs of digestion and assimilation are somehow or other concerned in the appearance of these sediments there can be no doubt, and that these organs should be somehow or other affected by the circumstances enumerated, there can be no difficulty in conceiving; but with respect to the immediate nature of these derangements, we have no very distinct knowledge; and at present I have nothing to do with conjecture.

Every one who has paid the least attention to the urine, must be aware that these sediments assume, at different times, very different appearances, especially in point of colour; and that they occur at different times, and in different persons, of almost every shade of colour, from nearly perfectly white to deep mahogany brownish red. This variety in appearance is doubtless connected with corresponding modifications in the diseases from which they originate; but as it would be endless, or impossible, to point out all those modifications, I shall consider them under three heads only, which will be found quite sufficient for all practical purposes, namely—1. *Yellow* sediments; 2. *Red or lateritious* sediments; and, 3. *Pink* sediments.

1. *Yellow sediments.* These sediments vary in colour from nearly white to the *wood brown* of Werner—a colour which is stated to be identical with that of ripe hazle nuts. They consist essentially of the lithate of ammonia, tinged with the colouring principle of the urine, but usually contain more or less of the phosphates, and sometimes a little of the lithate of soda. In general, perhaps, the nearer they approach to white, the more of the phosphates they contain: but there are many exceptions to this; and I have seen sediments belonging to this class almost perfectly white, and consisting of nearly pure lithate of ammonia.

This class of sediments may be termed the *sediments of health,* if the term may be allowed—being such as are produced in the urine of healthy or slightly dyspeptic individuals by errors of diet, and all the other circumstances before mentioned, which seem, independently of actual fever, to produce turbid urine. Perhaps there is no healthy individual whose urine does not occasionally deposit this species of sediment. There are some, however, infinitely more liable to it than others, and who consequently have it induced by the slightest causes. This susceptibility obviously denotes a tendency to an excess of lithic acid, and its consequences: but when these sediments are of an unusually pale colour, as is sometimes the case, a tendency to the phosphates is indicated, as will be more particularly pointed out hereafter. Children are very subject to this form of sediment; and in them, as well as in all who labour under such a susceptibility, it is frequently the forerunner of gravel or calculus. Indeed, nothing is more common than for this form of sediment to alternate in the urine of the same person with the crystallized sediment or *gravel* to be presently described.* Pale coloured varieties of this class of sediments, when abundant, and when there is a slight excess of acid in the urine, often subside to the bottom of the vessel in the form of a gelatinous-looking mass, which soon begins to assume either an amorphous or imperfectly crystallized form, at first on its surface, and afterwards gradually throughout its substance. This appearance, which also occurs in other forms of sediments, though more rarely, has been commonly attributed to mucus.

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* It may be observed, that rhubarb has the property, in some instances, of tinging these amorphous sediments of a bright yellow colour, when taken by the mouth.

2. *Red, or lateritious sediments.* These sediments vary in tint from nearly white, in which state they are with difficulty distinguished from the last variety, to a deep brick red or brown. They consist essentially of the lithate of ammonia, or lithate of soda, tinged with a large proportion of the colouring principle of the urine, and more or less of the purpurates of ammonia and soda. Sometimes, also, they contain a small proportion of the earthy phosphates. In general the deeper the tint, and the more approaching to *brick red,* the more of the lithate and purpurate of soda they contain: but there are some exceptions to this observation.

When the purpurates exist in the urine (indicating, as was formerly attempted to be shown, the secretion by the kidney of nitric acid), *feverish* or *inflammatory* action is almost constantly indicated: and this law is so general, that I have never seen a decided exception to it. The presence, therefore, of this class of sediments may be supposed to denote fever, and generally, I believe, of an active inflammatory nature. They owe their peculiarity of tint to the colouring matter of the urine, which, in common with all its other principles, appears on such occasions to be secreted more copiously than usual.

Hence, urine which deposits these sediments is usually of a deep red or brown colour, and of high specific gravity. The deeper the colour of the sediment, and the more approaching to *red*, the more severe in general the symptoms: and it may be mentioned, that the most decided and strongly marked specimens of this kind of sediment which I have seen, have been deposited by the urine of gouty individuals; in which case, as before observed, the sediments consisted chiefly of the lithate of soda, and the tinging substance, from the tint, appeared to be the purpurate of soda. The urine of all persons labouring under feverish and inflammatory affections, and whose urine is naturally healthy, is liable to deposit this species of sediment. Those however, who are most subject to the first variety, seem to be more liable to this, especially to the paler varieties of it. Such persons appear to be naturally of a feverish, irritable habit; and are apt to be affected by the slightest causes, such as trifling errors in diet, a chilly state of the atmosphere, &c. There are certain diseases, also, in which this variety of sediment appears to occur in a greater degree, and in a more decided form, than usual: such are gout, as above-mentioned; also rheumatism, hepatic affections, &c.*

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* A solution of the oxymuriate of mercury, as is well known, very constantly produces a precipitate in the deep coloured urine passed during fever or inflammatory action. This precipitate I have several times analyzed, and found it to consist chiefly of the lithate of mercury.

3. *Pink sediments.* The third and most rare variety of amorphous sediments, is what is usually denominated *pink* sediments, the colour of which is very aptly expressed by the term *pink*. Like the other varieties, they consist essentially of the lithate of ammonia; but they differ from both these in being almost entirely devoid of the yellow tint derived from the colouring matter of the urine; and consequently, in owing their colour chiefly to the purpurate of ammonia. This class of sediments, therefore, appears to indicate the absence of the large proportion of the colouring principle of the urine, so constantly present in active inflammatory fever, and to denote the secretion of a greater quantity of nitric acid, and the consequent formation of more of the purpurate of ammonia; and this view of the subject actually coincides with my observations. The most perfect specimens of this kind of sediment which I have ever seen were obtained from the urine of dropsical individuals: they occur also occasionally in the urine of the hectic, and of those obviously labouring under certain chronic visceral affections, especially of the liver.*

Such is an outline of the circumstances which have been observed respecting those amorphous sediments composed principally of the lithic acid. To render them, if possible, still more distinct, I shall briefly recapitulate them: Amorphous sediments owe their colours to two classes of substances, differing from one another; the first of these is, apparently, an ingredient of healthy urine, and helps to impart a yellow colour to that fluid. This ingredient is liable to be very much increased in active inflammatory fevers, though, of course, its presence does not necessarily indicate fever. The second source of colour is the purpurates, a class of substances not existing in healthy urine, but in that only of persons labouring under fever. These two substances naturally give rise to three varieties of sediments: 1. Lithate of ammonia tinged by the colouring matter of the urine only, and not necessarily indicating fever: 2. Tinged by a mixture of an excess of the same ingredient, and more or less of the purpurates, indicating for the most part active inflammatory fever; and, 3. Tinged by the purpurate of ammonia only, indicating general fever, of an irritable nature, as *hectic*? *

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* In one or two cases of obstinate dyspepsia, connected with formidable visceral obstruction, I have seen the urine not only passed of a bright pink colour, but remain so on cooling without depositing any sediment. This pink colour seemed to depend on the large quantity of purpurate of ammonia present, which, from there being no lithate of ammonia with which it might combine and be precipitated, was necessarily retained in solution.

It may be also remarked, that the above holds only with respect to the *healthy* action of the kidney. When this organ is deranged, as in diabetes, for example, the colouring principle which usually accompanies the lithic acid, as well as the lithic acid itself, are scarcely secreted at all, and consequently, sediments of the above description cannot take place; in such instances, therefore, fevers can, and do exist, without these appearances.* I wish, also, further to remark, that these sediments appear to me to show rather that fever *has existed, and is going off*, than that it *exists at present.* They never appear, I believe, during the first, or cold stage of fever, and properly belong to the last, or sweating stage. In continued fevers, indeed, they sometimes occur almost constantly; but this, I presume, can be explained, upon the supposition, that the sediments, for example, generated by the fever of yesterday, appear in the urine secreted during the remission of to-day; and those generated to-day in the urine of to-morrow, &c. The length of time which the urine is sometimes retained by feverish patients, and the consequent mixture of portions secreted at different times, has thrown a good deal of confusion on this part of the subject, which a simple attention to the above points will, for the most part, set to rights.

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* The best mode of judging of the real nature of these sediments, is, to collect them on a filter, and examine them while still wet. It is impossible to judge of their precise tint when in the urine; and if permitted to dry, they become much paler, and their colour cannot be completely restored.

Besides these amorphous sediments, consisting chiefly of lithic acid, I have seen two or three instances in which large quantities of perfectly *white* lithate of soda were deposited from the urine. In one case in particular the quantity was immense, and voided, not only mixed with the urine, but in a state of consistency like mortar, especially during the night, so as to produce considerable difficulty in passing the urine. The urine was *acid*, and this circumstance induced me to examine it, as the sediment had all the appearance of the mixed phosphates. I suspected the presence of gouty irritation or abscess in the kidneys in these instances.

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* I have, however, seen in a case of common inflammatory sore throat, where the phosphates were usually deposited in abundance, the lithate of ammonia intermixed with them, but in a *perfectly white* state.

II. *Of crystallized sediments, or gravel.* Crystallized sediments, or red gravel, consist of lithic acid, nearly pure. Lithic acid, as has been before stated, exists in a state of combination in healthy urine; and in such a proportion, as to be held in a state of solution at all ordinary temperatures. Sometimes, however, a free acid is generated by the kidneys, which precipitates the lithic acid in the pure crystallized state we see it—a phenomenon easily imitated artificially, as is well known, by the addition of a few drops of any acid to healthy urine. The precipitation of crystallized lithic acid does not, therefore, necessarily indicate an excess of lithic acid in the urine, but the presence only of some free acid in that fluid;* though such an excess does, for the most part, exist in this form of disease, as will be shown hereafter. With respect to the nature of the precipitating acid it is probably not always the same. Most generally it appears to be the *muriatic*, sometimes the *phosphoric* or *sulphuric*, and occasionally other acids. In general, however, it is to be understood, as noticed elsewhere, that when the mineral acids are present in excess, these are not the *immediate* cause of the preternatural acidity in the urine, and consequently of the precipitation of the lithic acid. The stronger acids act by decomposing saline compounds, into which destructible acids, such as the lactic acid, &c. enter, and setting them free; hence the *immediate* cause of the deposition of lithic acid gravel is generally a destructible acid of very weak powers, even, perhaps, in some instances, the carbonic acid. When the urine contains a free acid it is commonly more transparent than usual, and of a bright copper colour.*

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* I have frequently seen the urine so completely divested of lithic acid in this form of the disease, that, upon adding to it even an excess of a mineral acid, not another particle of lithic acid has been deposited.

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* It may be proper to remark, that Mr. Murray Forbes, in a work originally published so long ago as 1786, entitled "*A Treatise upon Gravel, and upon Gout, in which their Sources and Connections are ascertained, &c.* advanced opinions very similar to the above, respecting the deposition of amorphous and crystallized sediments. Indeed, if this gentleman had been better acquainted with the chemical properties of these substances, there is no doubt but he would have come to exactly the same conclusions. In 1792, Dr. Wilson Philip also published a valuable series of experiments, on the effects of different articles of food, &c. on the urine; in which a similar opinion respecting the deposition of lithic acid crystals, by the presence of a free acid, is maintained; but for this opinion he appears to acknowledge himself indebted to Mr. Forbes. Dr. Philip's experiments have been republished, with some additional observations, in the 6th vol. of the "Transactions of the Royal College of Phy-

This form of sediment varies considerably in its colour and appearance according to circumstances. When unaccompanied by fever its colour is always identical with the deeper tints of that of the first class of amorphous sediments before described. When it is accompanied by fever it is generally more or less of a red or lateritious colour. I have never seen this form of sediment of a *pink* colour, and for obvious reasons it is not likely that such an occurrence should take place. Sometimes large quantities of impure or imperfectly crystallized lithic acid is voided by old people, in the shape of globules, varying in size from a pin's head to that of small peas; these are generally pale coloured. Occasionally also, when the kidney is diseased, large irregular masses of this acid, in an impure state, are voided.

The general symptoms attending the appearance of crystallized lithic acid in the urine, are more or less of pain or uneasiness in the region of the kidney, with irritation, and sense of heat about the neck of the bladder and urethra. There is also a frequent de-

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sicians." Dr. Philip is of opinion, that the precipitating acid, in a healthy state of the system, is thrown off by the skin; and he supposes, that even when generated in excess, it may be diverted to the surface of the body by merely increasing insensible perspiration. Though I do not entirely coincide with this opinion of Dr. Philip, yet, upon other grounds, I fully agree with him in the propriety, and even necessity, of ensuring a due performance of the cutaneous functions in these complaints. It may be remarked, that what Dr. Philip termed *cream coloured sediments* in the first edition of his paper, and *phosphates* in that since published, evidently consisted in many instances of the lithate of ammonia.

sire to pass the urine, which is voided in small quantities at a time, and without affording the usual relief, the sensation still continuing of something being left behind in the bladder. The digestive functions also, as in most cases where urinary deposites are concerned, are considerably deranged, or very liable to be so, and the patient is frequently troubled with acidity of the stomach, flatulency, &c. particularly after any little error in diet, as the use of fruits, acescent wines, &c. The circumstances, however, under which lithic acid appears in the urine, and the constitutional symptoms with which it is associated, together with the tendency and danger of the affection, are liable to considerable modifications, according to the age of the patient; hence we shall consider the subject as occurring at four periods, viz. before puberty; between puberty and the age of forty; between forty and sixty; and in old age.

Children in general, and particularly the children of dyspeptic and gouty individuals, or who inherit a tendency to urinary diseases, are exceedingly liable to lithic acid deposites in the urine. These appear not only under the form of amorphous sediments, as before mentioned, when there is seldom much irritation in the urinary organs, but frequently also in the form of crystallized lithic acid: in this case symptoms of irritation about the urinary organs may be always more or less observed, if the child be attended to. Thus there will be found to be a frequent desire to pass urine, which is voided in very small quantities, and with manifest uneasiness. The irritation about the urinary organs also frequently induces the child to wet the bed by night, &c. In such cases, if the urine be examined, it will be always found to be very unnatural, and frequently loaded with lithic acid; and should this prove to be the fact, the case requires immediate attention, as there is much greater risk at this period of life than at any other, of the formation of stone in the bladder, as will be more particularly shown hereafter.

Between the age of puberty and forty there is, perhaps, generally speaking, less disposition to the formation of lithic acid deposites than at any other period of life. In those, however, who have a very strong disposition to urinary affections, they not only frequently occur, even during this period, but go on almost constantly in some shape or other, and in different degrees, according to circumstances. Except, however, in extreme cases, the lithic acid comes away in the state of gravel only, and hence the secondary symptoms, such as irritation in the urinary organs, &c. are by no means severe, and consequently attract but little of the patient's attention; more especially as his general health, however paradoxical it may appear, will be generally found to be in a better state than ordinary at those periods when lithic acid gravel is deposited in the urine. Partly for the reasons above stated, and partly from other circumstances to be noticed hereafter, there is less risk at this period of life of the formation of calculi than at any other; and hence this occurrence seldom takes place, except by accident, or when there is more than ordinary disposition to the disease.

About the age of forty an important change commonly takes place in the constitution, which for the most part materially influences the deposition of lithic acid in the urine. It will be generally now observed that the lithic acid is apt to be deposited at intervals in larger quantities than usual, and that for some time previously to this occurrence there is more or less of feverish indisposition and derangement of the general health: about this period of life also there is a disposition in the constitution, at the above periods particularly, to separate the lithic acid in a concrete state, thus giving origin to the formation of renal calculus, and the consequent train of secondary symptoms, to be detailed presently, when we come to speak particularly of that occurrence. These circumstances are most liable to take place in those individuals who have all their lives been subject to lithic acid deposites; but they not unfrequently occur also at the period of life we are considering, in those who have never previously suffered from these affections, but who have lived luxuriously and indolently, or who inherit a tendency to gout, though they have never, perhaps, had an open attack of that disease.

Whoever has much attended to urinary diseases must have remarked the circumstance above alluded to, viz. that patients subject to derangements of the general health, connected with urinary deposites, seldom feel so well with respect to the former, as when lithic acid gravel is deposited in the urine. Now this circumstance is even more strikingly illustrated by those attacks of gravel that are apt to commence about the period of life we are considering. Thus we shall frequently find, that patients who had previously for months, or even years, been subject to various anomalous nervous affections and pains in different parts of the system, accompanied by great derangement of the digestive functions, will suddenly obtain relief from the whole, by a discharge of lithic acid gravel in the urine, or, perhaps, a small renal calculus. Now, although it would be absurd to consider the lithic acid in such cases as the real *materies morbi*, yet, in many instances, about this period of life, we may begin to consider it as the symbol or representative of such a *materies*, and treat it accordingly: that is to say, we may frequently produce much relief to the system at large by promoting or producing artificially a discharge of lithic acid with the urine, as will be pointed out more particularly when we come to speak of the treatment of these affections.

The above state of things will sometimes continue, or at least occur, till old age, but frequently about the age of sixty or seventy another change takes place in the mode in which the lithic acid is separated from the system. At this period of life the urinary organs not only begin to participate in the general decay of the constitution, but are apt to be deranged in a particular manner from other causes, and more particularly to suffer from the delinquencies of early life.

Frequently also they become organically diseased, and this circumstance, in conjunction perhaps with others that will be noticed hereafter, produces a disposition in the system to secrete neutral urine, or even the earthy phosphates. Under these circumstances, where the urine had previously for years deposited the lithic acid chiefly in the state of crystals, these will in a great measure disappear, and instead of them, impure or imperfect lithic acid in the shape of minute globules of various sizes will be separated from the kidneys in great abundance. In most of these cases there is a good deal of pain in the back and irritation about the urinary organs, even when the concretions are only of small size. In others there is much less irritation under these circumstances than one could imagine. In all instances, however, this may be considered as a most dangerous state of disease, not only from the constant liability of the patient to the formation of renal or vesical calculi, which all other circumstances likewise conspire to render probable, but on the other hand, from the danger there is of suddenly checking the secretion of lithic acid, which is sometimes followed by great derangement of the general health and apoplexy.*

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* In one instance, under these circumstances, I witnessed an affection of the heart, accompanied by symptoms of *angina pectoris* take place soon afterwards. By a timely application of appropriate remedies these were considerably mitigated, and the gentleman, who is upwards of sixty, is still living, and continues not only perfectly free from gravel, but is very little troubled with the other affections.

Lastly, organic diseases of the kidney, or even of the parts contiguous, are exceedingly apt to be accompanied in some habits by the secretion of a large proportion of lithic acid. Thus nothing is more common than to see those who have suffered from hepatic affections in hot climates, &c. labour under gravel, and in such cases the right kidney is almost always the evident seat of the disease.

These observations naturally bring me, in the last place, to make a few remarks on the circumstances usually attending the formation of a nephritic calculus, or what is termed a *fit of the gravel.*

The urine of those individuals who possess a disposition to the disease, continues, as just observed, for a great length of time, perhaps almost constantly, to deposit lithic acid in some form or other. This, being accompanied by no very remarkable or severe symptoms, often escapes their observation; they proceed, therefore, in their usual habits, while the disease insidiously continues to gain ground daily: at length, about the age of forty, the affection begins to assume its most aggravated form, and both crystallized and amorphous sediments appear in the urine, sometimes in enormous quantities; at the same time, a peculiar state of the system, accompanied by fever, and closely resembling that present in gout, to which it is generally referred, comes on; the urine is now very much diminished in quantity (ofter amounting almost to suppression), its specific gravity unusually great, its colour very deep, the sediments unusually large (or occasionally they disappear altogether); and under these circumstances, lithic acid is separated by the kidney in the state of a semifluid hydrate, which becoming solid gives origin to renal calculus. During the above state there is commonly a sense of dull pain, or weight, in the region of the kidney, and just above the pubes; but as these are not particularly severe, they are little attended to; and after a few days the whole gradually subside, or perhaps terminate in an attack of the gout. Sooner or later, after the above symptoms but commonly not till they have subsided, and the urine has begun to be secreted in its usual quantity, the patient is seized all at once, and perhaps without the least warning, with a most acute pain in the region of the kidney, accompanied by violent sickness and vomiting, and other symptoms to be hereafter described, when we come to treat of the mechanical effects of these concretions.

Such is the history of a nephritic attack, as I am convinced I have seen it, and, as it seems most usually to occur, where the lithic acid is concerned. Of course, I cannot positively assert that the nucleus is generated during the existence of the symptoms above described; but I have met with such strong evidence of it, that no doubt of the subject has been left in my mind. I do not see, also, how it is possible to account for the sudden nephritic attacks which frequently take place during perfect health, except on the supposition, that the calculus had been formed before, and had lain for some time in the kidney, which it very frequently appears to do, without producing much pain, or even uneasiness. I admit that it is extremely difficult to get at the truth on these points; the attention of patients being, generally, too much taken up with their present sufferings, to attend to what took place some time before, and particularly to what was slight compared to the present, and, in their estimation, little connected with it. Besides, the calculus might have been formed months or years before, and thus the symptoms attending its formation have altogether escaped their memory.

In recapitulating the circumstances which give origin to these sediments, in general, it may be stated, that they are of two general descriptions, *natural* or *acquired*. With respect to those of the first description, it cannot, I think, be doubted, that certain individuals are much more liable to these sediments than others. This tendency, as before remarked, with respect to urinary affections in general, is not unfrequently inherited; thus, I knew a family where both the grandfather and father appeared to have lithic calculi in the bladder; and where the grandson has a very strong tendency to the same disease; his urine depositing frequently very large quantities of lithic acid, both in the form of amorphous and crystallized sediments. Sir Gilbert Blane has remarked also, that he has frequently observed calculous complaints connected with cutaneous affections, and "particularly with those impetiginous affections which depend on an hereditary constitution, and incident to what is called a scorbutic habit."* Now this precisely accords with my own observations, not only with respect to urinary diseases, but with respect also to organic affections in general of the urinary organs; and I had made the remark long before I was aware that it had been noticed by any one else: I think I have also remarked, that individuals who are subject to urinary derangements, are apt to be liable to that dangerous affection termed *diffuse* inflammation, which consists in a gradual extension of inflammatory action from a trifling wound over the whole system. On the other hand, the disposition to generate these sediments in excess, is, like gout, or rather simultaneously with gout, but too frequently acquired by indolent habits, and excess in eating and drinking. Most frequently, however, the tendency to these diseases is connected with some unknown causes, peculiar to certain districts or countries, as, for example, the district of which Norwich may be considered as the centre; in which more calculous cases occur than in the whole of Ireland or Scotland. In such instances, the water, diet, temperature, &c. of the district, has been each accused, in its turn, of being the exciting cause; and that hard waters, in conjunction with other favourable circumstances, have a great influence in producing this affection, I have no doubt.* I have also in one or two instances seen a fit of lithic gravel induced in the predisposed, by sitting on a damp cold seat for some hours; and sometimes a tendency to deposite large quantities of lithic acid is evidently connected with local injury or disease of the kidney.

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* See "An Essay on the Effect of the Pure Alkalies in various Complaints," in a work before referred to, entitled "Select Dissertations on several Subjects of Medical Science, by Sir G. Blane, Bart." p. 203.

With respect to the general prognosis where amorphous sediments are concerned, it may be stated, that they are of a more formidable character, in proportion as they are whiter, or of a more pure pink colour. When pale coloured, they denote, in general, a tendency to the phosphates; and when of a pink colour, generally some organic, or other deeply seated disease. But in drawing our conclusions, other circumstances must commonly be taken into account, and particularly the more or less constant deposition, and the greater or less quantity, of these sediments. A constant deposition of amorphous sediments in large quantity will almost certainly, sooner or later, end in an attack of gravel or calculus: the occasional deposition of the sediments in small quantity, is seldom attended by much danger.

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* From remarking the very great tendency to deposit lithic
, produced by hard-boiled dumplings, badly fermented
&c. I have sometimes thought, that if such articles con-
a large proportion of the food of a district, in which
ters also prevailed, its inhabitants might probably be
calculous affections.

Nearly the same remarks may be made with respect to lithic acid gravel. Generally speaking, except a calculus already exists in the kidney or bladder, the appearance of this is not dangerous, *as long as it is not deposited while the urine is warm.* When deposited in very large quantity, or in a state disposed to concrete together, there is great risk of the formation of calculus.

After these general remarks upon this most important class of urinary diseases, we come to consider the means by which they are to be counteracted, and their distressing consequences prevented.

Amorphous sediments; first variety. The frequent appearance of this variety of sediment, indicates, as we before stated, a strong tendency to the lithic acid diathesis and its consequences. In general it is not accompanied by any prominent symptoms, and fever in particular is altogether absent, or very slight. Hence this state of the affection scarcely requires a formal treatment with medicine, but a careful attention on the part of the patient, to avoid all the circumstances which have a tendency to aggravate the disease; in particular, to avoid those errors in diet, exercise, &c. which have been before stated to frequently give origin to this deposite in the predisposed. Of these, errors in diet, from their being most liable to be constant, are of the chief importance; and the error of *quantity* in diet is of infinitely more importance than the error of *quality.* *Any stomach may digest a* LITTLE *of any thing but no stomach can digest a* GREAT DEAL *of any* *thing.* This is a maxim that ought to be universally borne in mind where diet is concerned, and is in particular of the very first consequence in the present diseases. I do not mean that individuals subject to these affections should indulge themselves with a little of whatever comes in their way; such a licence, from the modes in which the term *a little* would be construed by different individuals, would be exceedingly dangerous: on the contrary, they should abstain altogether from things which manifestly disagree with them, and which must be unwholesome to all, such as heavy unfermented bread, hard boiled and fat puddings, salted and dried meats, acescent fruits, and (if the digestive organs be much debilitated) soups of every kind, &c. In general also, malt liquors and wines, particularly when of an acescent quality, should be avoided. Simple attention to these rules, with respect to diet and exercise, the ensuring a due performance of the cutaneous functions by wearing flannel (particularly about the loins), the preserving a regular state of the bowels, and, perhaps, the occasional use of alterative medicines, are all that are commonly requisite in this form of the complaint, and will scarcely ever fail to prevent its terminating in serious consequences.

When these sediments are very pale coloured, and liable to be produced by the slightest causes, as trifling errors in diet, a chilly state of the atmosphere, &c. they commonly denote, as before stated, a feverish irritability of the system, bordering upon that which accompanies the phosphates. In this state they are more dangerous, and require a kind of treatment to be hereafter more particularly described when we come to speak of the phosphatic diathesis.

Second and third varieties. The second variety of sediment, as has been already stated, does not necessarily indicate any specific disease, but is rather to be considered as a symptom of phlogistic fever, or very frequently of local inflammatory action. Of course the general treatment must correspond with this state of the system, while the particular treatment will depend upon the organ particularly affected. The same is true of the third variety, in which the fever, though very different from phlogistic fever in its character, may yet be produced by affections situated in various organs. These circumstances of course render it difficult, as well as unnecessary to be more particular in this place respecting the mode of treatment.

Crystallized sediments, or gravel. This most important form of disease, when habitual and existing in a great degree, and permitted to proceed unchecked, will, as before observed, almost certainly sooner or later terminate in serious consequences. With respect to the principles of treatment calculated to eradicate or remove the affection, these are pretty nearly the same in all the different modifications before noticed; though under particular circumstances, and especially after the age of forty, a mode of treatment founded upon principles somewhat different may be frequently adopted with advantage.

The following are the general principles on which this complaint may be treated in all instances, with a view principally to its eradication or removal. In the first place, strict attention and perseverance in the regimen above pointed out as proper in habitual amorphous sediments is absolutely necessary. If this point be neglected all others are of very little importance. Secondly, it is in this form of disease that the use of *alkaline* remedies is, for the most part, particularly indicated. These, however, must *never be trusted to alone,* and to be really useful must be conjoined with other means, and especially with alteratives and purgatives. Thus the pil. submur. hydrarg. comp. or a pill composed of the pil. hydrarg. and pulv. antimonialis may be taken twice or thrice a week at bed time, and followed up the next morning by an active dose of the subsulphate of magnesia; or a mixture of Rochelle salts, and magnesia, or carbonate of soda. A little of either of these compounds may be also taken twice or thrice in the day, so as to keep the urine constantly neutral or alkaline, and the bowels freely open; or gr. x to xx of magnesia may be taken for the same purpose in a glass of soda water, as often as it may be found necessary.* At the same time, the use of hard waters, such, for example, as most of the pump-waters in and about London, should be particularly avoided. The Thames and New River water boiled and filtered are unobjectionable, as are most of the waters in this neighbourhood, which come from a great depth and are obtained by the new process of boring. Indeed I have known the latter (probably from their occasionally containing a little carbonated alkali in solution) sometimes agree particularly well in this form of disease, and even give ease where calculi actually existed in the bladder, when almost nothing else would.

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* Sir G. Blane, in the essays above quoted, first pointed out the effects of saline compounds containing a vegetable acid in rendering the urine alkaline; but this circumstance seems to have attracted little attention; and, indeed, even at the present time is, I fear, very far from being generally known; otherwise the common saline draught would be exhibited with a little more caution than it sometimes is in urinary and vesical diseases.

Sometimes warm sea-bathing is particularly beneficial, though in other instances the gravelly deposite seems to be increased under its use: this latter circumstance I have been inclined to ascribe to the use of the hard waters that generally prevail along the coast; though in some cases it may arise from the determination of the constitutional derangement to the kidneys.

The above plan is to be persisted in *for a considerable length of time*, according to the severity and obstinacy of the symptoms;* the alterative pill

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In most cases of the form of disease we are now considering there is not a more effectual remedy; but in other states of urinary disease, were I required to name the remedy calculated to do the most mischief, I should name the common saline draught, formed of potash or soda, *and some vegetable acid*. This subject will be considered more fully hereafter.

* I cannot too strongly impress on my readers the important fact, that in urinary diseases, almost more than in any others,

being gradually had recourse to at longer intervals, and the doses of the other medicines diminished in a corresponding manner. If there be much irritation, recourse may be had to hyoscyamus or opium; and acidity of the stomach, flatulency, or other accidental and frequently concomitant symptoms, must be obviated by the usual means.

In what has been said I wish it to be particularly understood, that I have only attempted to lay down general *principles;* of course, therefore, it is not intended that the above plan should be strictly adhered to in all its details, which must be varied according to circumstances. Thus a course of the Malvern or Cheltenham waters may, in many instances, be advantageously had recourse to in conjunction with the alterative and alkaline plan. There may be cases also where purgatives to such an extent as here recommended may be improper. Indeed in no instance they ought to be carried to excess, but should be so administered in the outset as to keep the bowels

owing to their constitutional and deep-rooted character, perseverance is particularly necessary. It is absurd to look for permanent relief in these complaints by attention to regimen or medicine for a few days or weeks: in obstinate cases an adherence more or less strict, according to circumstances, to the principles above stated, should be adopted for months, or even for years, to ensure success. This will be scarcely thought irksome by those who affix a just value on health; by a few sensualists it may be considered a species of slavery and sacrifice of enjoyment, too great to be endured for any *future* good whatever.

rather freely open, and no more; and as the disease recedes to insure their natural action.

The above plan is particularly adapted for preventing the effects of, and eradicating the disease in early life, when a tendency to it has been inherited, or is otherwise habitual; and, perhaps, it may not be deemed superfluous here to insist upon the absolute necessity there is for attending to the subject when children are concerned. In such cases it should be constantly borne in mind, that by proper care the formation of stone in the bladder may almost certainly be prevented, but that by inattention this dreadful occurrence is as certainly likely to take place; as I have seen happen, for example, when children, under such circumstances, have been sent to school and neglected. It seems, therefore, to be a duty highly incumbent on parents to attend to this point; nor should such children ever be considered as secure till after the age of puberty, when the tendency to this affection is commonly much diminished, or at least becomes much less dangerous; and when, of course, they are able to look after themselves.

We have said, that about the age of forty the lithic acid may not inaptly be considered as a sort of *materies morbi;* that is to say, the cause of irritation in the constitution, whatever it may be, seems to be transferred to the kidneys, which are thus induced to secrete an extraordinary quantity of lithic acid, and by this means to give great relief to the system at large. Upon this principle it is, that the good effects long ascribed to certain remedies of the active diuretic kind may be probably explained; such remedies appearing to possess the power, when given in certain favourable conditions of the system, of exciting the kidneys to secrete large quantities of lithic acid, and, in this way, by bringing about a sort of artificial crisis, to produce great temporary relief. Thus, Dr. Henry has mentioned cases in which *several ounces* of lithic acid were brought away in the course of a day or two, by a remedy apparently composed of turpentine and laudanum chiefly.*

In remedies of this class, opium, not only on account of its sedative properties, but likewise from the property it possesses of increasing the secretion of lithic acid, should probably in most instances form a constituent principle; but the diuretic ingredients may vary. Thus instead of turpentine, a combination of muriatic acid and opium will sometimes answer very well, particularly when the lithic acid is not disposed to concrete, but comes away in the form of gravel; or the terebinthine remedy may be conjoined with the acid and opium. When, on the contrary, the lithic acid is more disposed to concrete, the muriatic acid may be omitted, and potash may be substituted, by which means the lithic acid will be held in solution; and this, perhaps, in most instances is the safer combination. To this class may be likewise referred many of the ancient and still popular remedies in gravelly affections, such as the seeds of the wild carrot, the parsley breakstone (*alchemilla arvensis*) &c. many of which produce a large secretion of lithic acid in particular states of the system. Even *hard waters*, however paradoxical it may appear, sometimes do good on the same principle; and by acting as diuretics bring away large quantities of gravel, as I have known more than once happen. Occasionally, however, a mere change of water, not only from soft to hard, but the reverse, will have the same effect.

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* Med. Chirurg. Trans. x. 136. Dr. Henry thinks, that in these cases the lithic acid brought away was previously lodged in the kidneys; this might have been the case in part, though I cannot help thinking that by far the greater part of it was actually secreted under the influence of the medicine.

That such remedies are calculated to do good, when judiciously applied, there can be no doubt; but, on the other hand, when indiscriminately exhibited, they are liable to do much harm. Thus when there is a tendency to active inflammation in the kidney, or when the presence of a renal calculus is suspected too large to pass down the ureter, their exhibition will be likely to increase the affection: nor does their employment seem to be adapted to any other species of deposite, except crystallized lithic acid, nor even perhaps to this form of the disease, when occurring in very young or in very old subjects. Hence as this class of remedies do not appear to exert any beneficial action in any case, in removing the tendency to gravel, but are calculated to answer a particular and temporary purpose only, the moment this has been effected, they should be no longer employed, but the means above recommended, as adapted to prevent a tendency to the affection, be recurred to.

Perhaps the most dangerous form in every point of view which the lithic acid assumes, as well as the most difficult of treatment, is that above described, as occasionally occurring in old people. For, on the one hand, if a sudden stop be put to the secretion, whether by the appropriate remedies or otherwise, great constitutional derangement is liable to follow, with sudden and fatal determination to the head or other parts, as I have more than once known happen. On the other hand, if permitted to proceed unchecked, from the combined effects of so many concurring circumstances at this time of life, the formation of calculus in the bladder will almost certainly take place. In such cases it is impossible to lay down any specific plan of cure, which must depend on circumstances; but in general the principles of treatment must be of the constitutional and preventive kind formerly laid down, and in conjunction with these the frequent application of leeches to the region of the kidney, or an issue or seton in the back, may be had recourse to, particularly if the presence of organic disease be suspected.

I come now to consider the treatment to be adopted in the last and most severe stage of these affections, or what is usually denominated a *fit of the gravel.*

A fit of the gravel consists in the secretion of a large portion of lithic acid by the kidney, under the circumstance above-mentioned, and is usually preceded, as well as accompanied, by much constitutional derangement, with tendency to fever and inflammation. The principles of the treatment to be adopted, in this form of the disease, closely resemble those recommended in gravel, except that they must be more active. When the attack is acute, venesection or cupping from the region of the kidney, with active doses of calomel and antimonial powder (or omitting the latter if nausea be present, and substituting opium or hyoscyamus), should be immediately had recourse to, and *precede the use of diuretic remedies.** When these have begun to operate sensibly upon the system, though, perhaps, before the purgatives have produced actual stools, the patient may have recourse to warm fomentations about the region of the kidneys, or, what is much better the warm bath, and commence the use of the diuretic purgatives formerly mentioned, with the addition of colchicum: and these means, if judiciously and vigorously applied, seldom fail of removing the inflammatory or spasmodic action of the kidney, and of producing a flow of urine. If the attack has been taken in time, the formation of a calculus in the kidney will thus certainly be prevented; or at least what is formed will be very small, and scarcely ever fail to be brought away without producing those distressing symptoms which usually accompany the descent of a calculus down the ureter. It need scarcely be mentioned that a strict antiphlogistic regimen is to be adopted; and that the collateral and subsequent treatment must be regulated by the symptoms present, according to the judgment of the practitioner. After the more urgent symptoms have subsided, the patient should be warned of his danger, and be induced to submit to the regimen, &c. prescribed for gravel in the preceding pages. And if the case be very obstinate, or suspected to be accompanied by some local disease of the kidney, a large galbanum or other plaster may be applied to the lumbar region, or an issue or seton may be inserted in the neighbourhood of the kidney with great advantage.

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* I have seen great mischief done by the incautious use of stimulating diuretics at the commencement of the attack. The sufferings of the patient have been all aggravated, and his life has been placed in extreme danger.

CHAP. VII.

Of the Mulberry, or Oxalate of Lime Diathesis.

OXALATE of lime very rarely, if ever, appears alone under the form of an amorphous sediment. In some instances, as before-mentioned, it occurs mixed with the lithic amorphous sediments; but even this is not very common. Its appearance is still more rare under the form of crystallized gravel. I have only seen one instance of this, and am able to refer to one more only.* The gravel was given to me for examination; but I am ignorant of the particulars of the case.

Mr. Brande states, also, that in this diathesis there is little or no sand or gravel voided. He gives a few particulars of one case where a mulberry calculus was afterwards extracted. The patient was a man "62 years of age, and about five years previously had suffered a slight attack of the symptoms of a stone passing from the kidney to the bladder. *He had voided no sand, and his urine always appeared clear.* During the last two years the symptoms of stone in the bladder attained such violence, as to render the operation necessary; and a very perfectly-formed mulberry calculus, about the size of a nutmeg, with a distinct oxalate of lime nucleus, was removed." *

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* See Scudamore on Gout, p. 166, third edit. The author speaks as if he had seen this form of gravel; but he does not describe the particulars of the case.

Renal calculi of the oxalate of lime are not very uncommon. Twelve instances of this circumstance have fallen under my observation, the particulars of which I am more or less acquainted with. The following is a summary account of them, which I offer as the best data at present known, illustrative of this form of urinary affection.

Case 1 occurred in a gentleman about 40, subject to gout, but who, otherwise, enjoyed good health, and had never been subject to gravel, or other urinary affection. What is singular, this gentleman had never felt the least inconvenience from it, either when it descended from the kidney, or passed the urethra, though it was of a very considerable size, and, like most of these calculi, very rough externally.

Cases 2 and 3 occurred in middle-aged women, of whose health I can give no very precise particulars, except that they appeared well when I saw them, which was several years after the stones had passed from the bladder; and they had suffered from no recurrence of the disease.

Case 4. That of a gentleman about 40, of sedentary habits, but free from gout. The stone was small,

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* Royal Institution Journal, viii. p. 213.

but caused acute suffering in descending from the kidney. This occurred three years ago, and since that time he has had no recurrence of the symptoms, and enjoyed good health.

Case 5 occurred in a nobleman between 40 and 50, who had been occasionally subject to gout for some years. He had also suffered from lithic acid gravel, and had had one or two nephritic attacks, in which lithic acid calculi had been voided. The nephritic attack came on, in the present instance, subsequently to more moderate attacks of the gravel, and was attended by the usual symptoms, though not in a very severe degree; after the nephritic symptoms subsided, two small calculi were passed from the bladder, at an interval of a day or two, and since that time (three years ago), though he has had gout, he has had no recurrence of the disease. The urine during the attack was rather scanty and high coloured, and without any sediment; and, in short, appeared to differ in no respect from that usually secreted in ordinary fever.

Cases 6 and 7. For these I am indebted to Mr. Earle, who was kind enough to bring me the calculi for examination. The first was passed by a middle-aged lady, with a great deal of pain and irritation. The second was from a boy of nine years of age, in whom it had lodged in the urethra, whence it was obliged to be extracted by incision. Of this case I can give no further particulars.

Case 8. This was the case of a woman about 30 years of age, who suffered a great deal during its descent from the kidney. The calculus was very rough, and composed of spicular crystals nearly white, and easily separable from one another. The urine, soon after the attack was over, possessed no remarkable appearance. Of this case I have not since heard any particulars.

Case 9 occurred in a captain of the navy, about 60 years of age, of a gouty family, though he had never had gout himself, and who, in general, was active and temperate, and enjoyed good health. Within the last 14 years he had passed four calculi from the bladder. The two first of these were lithic acid; the last, composed of a congeries of pale-coloured crystals of oxalate of lime, was passed about three years before I saw him, which was in March, 1822. At that time he had every symptom of the presence of a small calculus in the bladder. The urine was of a pale citrine colour, and of sp. gr. 1019·8 acid, but yielded a copious precipitate of the mixed phosphates on the addition of ammonia, and of oxalate of lime on the addition of oxalate of ammonia. This gentleman had never seen gravel in his urine. It may be proper to remark, that between the appearance of the lithic acid, and oxalate of lime calculi, he had had a fall from a horse, which affected his back at the time, but left no permanent consequences. This gentleman resided in the country, and I have not since heard of him.

Case 10. This was the case of a gentleman between 40 and 50, of rather a delicate constitution, but who had never suffered from urinary diseases of any description. Soon after an attack of swelled testicle of unusual obstinacy, in which he had lost a great deal of blood, he was seized with pain in the kidney on the same side, accompanied by the usual symptoms of a nephritic attack, and which ended by his voiding a small mulberry calculus from the bladder. Shortly after this I saw him for the first time. He then complained of an uneasiness in the region of the kidney, and the urine was acid, and showed some marks of irritation, but these soon left him; and he has had no return of the affection.

Case 11 was that of an officer of rank in the army. He was between 40 and 50 years of age, strong and robust, and had always enjoyed good health, had never had gravel, nor any tendency to it. In this case, like the last, the nephritic attack came on after the subsidence of a swelling in the testicle on the same side, and was followed by the expulsion of a small calculus from the bladder. A few days after this I saw him for the first time. He was now perfectly free from pain, the urine was transparent, strongly acid, and upon standing some time deposited crystals of lithic acid.

Case 12 was of a gentleman about 40 years of age, who in the course of 18 months passed two small calculi from the kidney, with comparatively slight irritation in the urinary organs. After passing the second in August last, he still continued to feel uneasiness about the kidneys and urinary organs, which was attended with some derangement of the digestive functions; and the urine also, though generally clear, was not quite natural. These symptoms still continue, but whether they indicate the presence of another calculus in the kidney, or merely the constitutional irritation, sometimes productive of this formation, cannot at present be determined.

From these cases, then, we are authorized to draw the following conclusions:

1st. That this form of disease occurs in both sexes; that it may exist before puberty, and at all ages between that and 40 or 50, at which time it seems to occur most frequently; but that no case occurs beyond the age of sixty. Hence that it is probably not a disease of old age.

2d. That it is not incompatible with gout, but seems occasionally to be associated with it. I have also seen it connected, as lithic acid frequently is, with a tendency to cutaneous disease.

3d. That this variety of calculous affection occurs in individuals of sound constitutions, and who ordinarily enjoy good health; and that it rarely occurs a second time, except at long intervals, during which the intermediate health is good; which latter facts, it may be proper to observe, are confirmed by other observers, and particularly by Mr. Brande and Dr. Marcet.*

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* Marcet on Calculous Disorders, p. 78, first edit.

4th. That the urine is acid, and apparently but slightly deranged in this form of calculus, and remarkably free from all sort of sediment and gravel.*

5th. That as renal calculi of the oxalate of lime often subsequently acquire considerable magnitude in the bladder, it may be inferred, that the formation of this compound is connected with a distinct diathesis, excluding the existence of other diatheses, and that it is not an accidental occurrence, happening in common with many others to the urine.

6th. That from the dissection of calculi, formerly mentioned, it appears that the oxalate of lime diathesis is preceded and followed by the lithic acid diathesis, a circumstance which seems to be peculiar to these two forms of deposite, and which, when taken in conjunction with the other circumstances, already related, appears to show that they are of the same general nature; or in other words, that the oxalic acid merely takes place as it were of the lithic acid, and by combining with the lime naturally existing in the urine, forms the concretion in question.

7th. That the diathesis being of a similar nature, the principles of treatment adapted for counteracting the original tendency to it must be also similar, that is to say, of an antiphlogistic character; great attention being at the same time paid to the digestive and assimilative functions.

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* One circumstance I have remarked in the colour of the urine in this form of disease, which, whether it be characteristic or not, I do not at present know. This can be hardly described so as to be understood by another, but may be said to consist in a peculiar *yellow* tint, different from that usually present when the lithic acid prevails, which is usually more inclining to red.

Such nearly were the general conclusions which, from a limited observation and general analogy, I was induced to form when the first edition of this volume was printed; and I am happy to say, that further experience has confirmed the truth of these opinions. In all the instances in which I have myself had opportunity of witnessing this affection, the general health has been little affected, and the immediate attacks have been attended by considerable excitement, amounting in three of the instances to actual inflammation with fever, obviously requiring the treatment recommended in similar attacks where lithic acid was concerned, and which gave decided relief.

With respect to the means of determining when this diathesis is going on in the system, I am sorry that I can give but little positive information. The absence of urinary sediment, &c. are of a negative character, and lead to no inference, where other circumstances are wanting, as is most generally the case. But if there be pain in the region of the kidney, and other symptoms of gravel, without any appearance of sediment, and if the urine be acid, and of the yellow tint above alluded to, the stomach deranged, and an inflammatory diathesis, either general or local (i. e. about the urinary organs), be present; and if all these are associated with suppressed gout, or tendency to cutaneous disease, the existence of this form of the disease may be suspected, and means immediately taken to counteract it.

Besides the general principles of treatment above mentioned, I have lately adopted another principle, very different indeed from these, but which I think I have seen of considerable utility in two or three instances. This has been to endeavour to *change the diathesis from that of the oxalate of lime to the lithic acid.* It struck me, that as these two diatheses never appear to exist at the same time, if the former could be converted into the latter, that a very obscure disease would thus at least be exchanged for one of a more open character. The muriatic acid was chosen to effect this purpose (though in some instances it is probable that the vegetable acids would answer as well), and its use was continued till the lithic acid began to be deposited plentifully on the cooling of the urine. The muriatic acid is sometimes apt at first to derange the stomach; but notwithstanding this, in the few instances in which I have had an opportunity of adopting this plan, it has been always ultimately followed with very considerable relief to the patient's sufferings, both constitutional and local. Indeed, there are strong grounds for believing, from the analogy between the two diatheses, that an artificial expulsion of lithic acid from the system, under the above circumstances, is calculated, at a certain period of life, to remove the tendency to the formation of oxalic acid, in the same way, and on the same principles, that it was formerly stated to remove the tendency to the secretion of lithic acid.

It need scarcely be mentioned, that this plan of treatment requires some judgment and care in its management; and that it should hardly, in any case, be adopted when disorganization or calculus is already supposed to exist in the kidney or bladder, or perhaps in very young or very old subjects.

CHAP. VIII.

Cystic Oxide Diathesis.

THE cystic oxide diathesis constitutes a form of urinary derangement still less perfectly known than that of the oxalate of lime. This arises from its rarity, which is such that a very few instances of it have hitherto fallen under the observation of medical men. For my own part, I have only had one opportunity of seeing this affection, and therefore must chiefly satisfy myself with presenting my readers, from other sources, with a summary of the little that is known respecting this very rare species of calculus.

The first specimen, described by Dr. Wollaston, its discoverer, was taken from a boy five years old, and was covered with a loose coating of the phosphate of lime. This boy afterwards died from the formation of another stone, which consisted principally of the lithic acid, but was peculiar in having its centre hollow, by the removal apparently of some more soluble substance of which the nucleus had consisted.* The second specimen was likewise described by Dr. Wollaston, and is preserved in the collection of Guy's Hospital. It was taken from a man 36 years of age, of whose case no particulars are recorded.

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* Philos. Trans. 1810, p. 223.

Soon after the above paper was written, Dr. Henry recognized two specimens of this variety of calculus in his collection; but with the histories of both he was unacquainted.*

The next case on record is described by Dr. Marcet, in his work.† It was removed from the bladder of a gentleman when about 20 years of age. This gentleman, both before and after the operation, passed several small calculi composed of the same substance, all of which had been distinctly traced from the kidney down the ureter by the usual symptoms. After the operation he had no symptoms of stone in the bladder; those descending into that organ having been discharged immediately. His general health was good, except when the calculus was passing down the ureter; though he was rather subject to be bilious or dyspeptic; but was never troubled with acidity. Latterly, it is stated that the fit of pain previous to the evacuation of calculi, which used to occur about once in six months, had become much milder; and that the hæmorrhage had ceased, though the evacuation of calculous matter in small quantities had been even more frequent than formerly —perhaps about once a month.

For the two next instances we are likewise indebted to Dr. Marcet. The first of these occurred in a gentleman 30 years of age, who had died with symptoms of renal calculi. On examination after death, a number of calculi were found in the kidneys, which proved to be of this variety. The second case was that of an elder brother of the same gentleman, who had died of a similar affection, and in whose kidneys calculi of a similar kind were found, accompanied by extensive disorganization of the kidneys and prostate gland. It may be worth while also to remark, that a third brother of the same family died with symptoms of calculi; but their nature was not ascertained.

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* Marcet, p. 82, first edit.; Henry, Med. Chirurg. Trans. x. p. 140.

† Loc. cit.

Two cases of this form of disease have occurred to Mr. Brande, who has heard of no others. In one, the calculus was voided by a labourer; but no particulars were known of his case. In the other, several of these calculi, varying in size from a pin's head to that of a pea, had been voided at different times, during a period of thirty years, by a gentleman 40 years of age. He had been subject, from the age of six or seven years, to pain in the region of the loins, not confined to any particular spot, and seldom of any acuteness, or such as to prevent his ordinary occupations, which obliged him to lead rather a sedentary life. His usual state of health was good, his habits very regular, his diet ordinary and plain. He had used soda water, magnesia, and the alkalies, without any advantage. The further history of this case is unknown.*

I have recently had an opportunity of seeing a case of this rare form of disease through the kindness of Sir A. Cooper, who sent the gentleman to me to have the nature of the stone he had lately passed from the kidney ascertained. This gentleman appeared about 30 years of age. He had been subject to urinary diseases since 1818, when, in consequence of exposure to cold, he was seized with severe pain, accompanied by inflammation of the kidneys. Six months afterwards he, for the first time, observed retention of urine, from what appeared to be calculus in the bladder, and in 1820 a stone was extracted from the bladder, which weighed upwards of two ounces. The nature of this stone does not appear to have been ascertained, but it was *supposed* to be oxalate of lime. The present small calculus, which consisted of pure cystic oxide, passed down from the left kidney about a fortnight before I saw him, with considerable pain. Since that time he had been taking alkaline remedies, which appeared to give him more relief from the severe harassing pain in the back that he was almost always subject to, than any thing else. The urine voided in my presence, about five p. m. was copious, of a yellowish green colour, and strong peculiar smell. Its sp. gr. was 1·020, and almost immediately on being passed a greasy-looking film was formed on the surface, and at the same time rather a copious pale-coloured precipitate appeared, and the urine became alkaline. This film and sediment consisted chiefly of the triple phosphate of magnesia and ammonia, mixed with a little of the cystic oxide. There was very little urea, and hardly a trace of lithic acid was perceptible, on the addition of an acid.

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* Royal Institution Journal, viii. p. 71.

The urine passed the next morning early (all medicine having been in the mean time omitted,) was more remarkable and characteristic, I presume, of this affection. Its colour and appearance were much the same as the above, except that the former was a little deeper, and the peculiar smell stronger. It very faintly reddened litmus paper, and its sp. gr. was 1·022. There was a slight deposition on standing for some time, consisting of a mixture of the cystic oxide, with a little of the triple phosphate. A considerable proportion, however, of the cystic oxide was precipitated from the urine on the addition of acetic acid, which of course held at the same time the phosphates in solution.

This gentleman seemed strong and robust, but was liable to affections of the stomach, which appeared to arise, in part at least, from sympathy with the derangement of the kidney. What is remarkable, he stated that he had a twin brother likewise subject to urinary affections, but of what kind has not been ascertained.

In a late number of the Annals of Philosophy * Dr. Noehden, in a note to the editor, gives an extract from a letter he received from Prof. Stromeyer, in which he states that "he had recently the great

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* Annals of Philosophy (new series), viii. p. 146.

satisfaction of discovering the cystic oxide in gravel from the human body, and afterwards in the urine of the same patient, who is afflicted with the stone, the same substance in considerable quantity. In this urine the lithic acid was almost entirely wanting, nor was the urea found in it in natural quantity." M. Lassaigne has also lately found this substance in the form of calculus in the bladder of a dog.*

Dr. Marcet has observed that all the specimens of cystic oxide calculi are remarkable for *their purity*; and hence he remarks, that this diathesis has a more exclusive tendency in regard to the formation of other kinds of calculi than any other species of urinary concretion.† This observation seems to be confirmed by the examination of the urine above given, in which the absence of lithic acid, &c. was remarkable. Like the other two species of urinary concretions, however, it may be evidently followed by the phosphates, as appears from one of the specimens of calculus above described, and also from the examination of the urine, in which the tendency to the deposition of the phosphates had been evidently produced by the use of alkaline remedies. This diathesis, like the mulberry, may also be followed by the lithic acid diathesis, as happened in one of the instances given by Dr. Wollaston above quoted. Dr. Henry also mentions an instance of a lithic acid calculus having a nucleus of cystic oxide.

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* Ann. de Chimie et de Physique, xxiii. 328.—Also Annals of Philosophy (new series), vi. 316.

† This substance, from its peculiar plastic and adhesive nature, must be even more difficult to get rid of than a harder substance; hence from this circumstance, no less than from the large quantity in which it is occasionally secreted, it seems to be exceedingly liable to form concretions in the kidney and bladder.

From all the above circumstances taken together, I cannot help forming an unfavourable opinion respecting this rare species of disease. In most of the above cases where it could be traced, it seemed to be united with diseased kidney, of which it was either the consequence or cause; and in all an inveterate disposition to urinary disease, apparently inherited, was evident.

With respect to the medical treatment to be adopted, this will depend on circumstances. In the first place great attention should be paid to the digestive functions; and if the urine be acid, the alkalies may be taken with advantage; on the contrary, if alkaline, the muriatic acid: indeed, the latter, if the irritation present would permit it, might, perhaps, in all cases, be employed advantageously, not only with the view of retaining the cystic oxide in solution, but of inducing the lithic acid diathesis. From the diseased state of the kidney also, with which this diathesis seems to be so frequently associated, local counter-stimuli will be likely to be serviceable.

CHAP. IX.

Of the Phosphatic, or Earthy Diathesis.

It has been shown in a preceding chapter, that a deposition of the phosphates is very rarely an original affection, but represents a state of disease induced by, or consequent to the other forms of urinary deposition, and more especially the lithic acid, and oxalate of lime. Hence as this is the point towards which all the other diseases as it were converge, and as the change does not take place suddenly, it may not be deemed improper, in the first place, to make a few remarks on the state of the urine, &c. during the transition from the other forms of deposite to that of the phosphates.

Transition from the lithic to the phosphatic diathesis. The first circumstances in the condition of the urine which generally denote a change from the lithic acid to the phosphatic diathesis, are the general paleness of its colour, and sometimes its increased quantity. There is also, for the most part, a great tendency in the urine from the slightest causes to deposit the lithic amorphous sediments, which are always of a pale colour, and generally contain more or less of the phosphates intermixed with them. As the tendency to change proceeds, the urine may be frequently observed, after standing a few hours, to be covered with an iridescent pellicle on its surface, which on examination is found to consist principally of the triple phosphate of magnesia and ammonia: and if at this time it be suffered to remain at rest for a while, especially in warm weather, it becomes putrid, assumes a yellowish opaque appearance, and will be frequently found to contain large spicular crystals of the triple phosphate above mentioned.* This constitutes what may be considered as the *first* stage of the series of changes in question. I have once or twice known a calculus extracted from the bladder during this stage, which I have had an opportunity of examining; and in every instance found it externally composed of pale coloured lithate of ammonia nearly pure.

The above state of the urine frequently occurs in sickly children, in whom the functions of the digestive organs are much deranged. It is liable also to occur from all the causes formerly enumerated, and particularly in those of an irritable habit, and who are subject to lithic deposites in general; also from any cause deranging the general health, or producing local irritation in the urinary organs. As to the constitutional affections, they are always more or less of the irritable kind, and generally accompanied by derangements of the digestive organs. In adults, also, there is not unfrequently some uneasiness felt in the region of the kidney. With respect to the tendency and danger of this stage of change, it may be generally mitigated, or at least prevented from getting worse, by a judicious use of the means formerly mentioned, provided its exciting *causes* can be removed. But if these are permitted to operate, or are of such a nature that their operation cannot be prevented, medicines are of very little use; and the phosphatic diathesis will certainly sooner or later be induced, particularly if there be already calculus in the bladder.

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* I have seen crystals of this salt, upwards of half an inch in length, in urine not remarkably unhealthy, which has been permitted to stand for a great length of time, and grow putrid. Such crystals cannot, I believe, be formed artificially.

In the *second* stage of the change in question, the urine commonly assumes a more decidedly pale whey-like colour, and is either alkaline when voided, or very soon becomes so. The lithate of ammonia also diminishes in quantity, or entirely disappears; while that of the phosphates, and particularly the triple phosphate of magnesia and ammonia, is increased. In short, this stage runs into the confirmed phosphatic diathesis by such imperceptible grades, that it is frequently difficult or unnecessary to draw the line of distinction, the symptoms and treatment being the same in most instances, only differing, perhaps, a little in degree.

Transition from the oxalate of lime to the phosphatic diathesis. In a former chapter a summary description was given of a calculus composed of a nucleus of oxalate of lime surrounded by the phosphates, with an account of the series of intermediate changes which took place. From this description it appeared that the first step towards the change in question was a secretion of an excess of lime; and that, as this proceeded, the proportion of oxalic acid decreased, while that of the phosphoric acid increased, until at length phosphate of lime, in nearly a pure state, was secreted, which constituted the external crust of the calculus. I have seen the same series of changes in other instances. With respect to the urine I have had no opportunity of examining this in the earlier stages of these changes; but in the latter stages it assumes all the properties, as might be expected, of phosphatic urine.

Transition from the cystic oxide to the phosphatic diathesis. Of this, from the rarity of the disease, I can say very little. In the only instance, in which I have had an opportunity of examining the urine in the cystic oxide diathesis, this secretion was inclined to alkalescency, on account of the patient's having been taking alkaline remedies, and in this case the phosphates (or at least the triple phosphate of magnesia and ammonia) were intermixed with the cystic oxide, and the urine had much the appearance (independently of the peculiar characters connected with the rare principle in question) that it assumes in the transition stages from the other diatheses to the phosphates.

After these preliminary remarks, on what may be considered as the transition stages of the urine, and which may exist for a greater or less period according to circumstances, we come now to speak of a deposition of the phosphates in a decided form.

The phosphates like the lithates, as before observed, appear in the urine under two distinct forms, viz. in an *amorphous* state, and in the crystallized form; but here the analogy ceases, for in the case of the lithates the amorphous form is of comparatively the least consequence, whereas when the phosphates are concerned, the amorphous sediment is by far the most important and the crystallized form is usually of a much milder character. Hence we shall consider the crystallized form of sediment in the first place as a preliminary step to the more formidable disease.

1. *Of crystallized sediments composed of the phosphates.* These *almost invariably* consist of the triple phosphate of magnesia and ammonia, and exist in the form of perfectly white shining crystals.* This form of disease sometimes occurs alone, but very frequently it alternates, or is accompanied by the pale coloured lithic amorphous sediments, or the amorphous variety of phosphatic sediment, to be presently described; the constitutional symptoms also are, for

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* I have said, *almost invairably*; for, if I am not mistaken, I have once or twice seen a crystallized compound of the triple phosphate of magnesia and ammonia, and the phosphate of lime. These crystals were much larger than those of the triple phosphate, and less distinctly formed.

the most part, of the same general character, though much milder in degree. These usually consist of more or less derangement of the digestive functions, with much nervous irritation, and more or less of pain and uneasiness in the back or urinary organs, accompanied frequently with a sense of general lassitude and want of energy. The urine in this form of disease is generally abundant in quantity, and for the most part pale coloured (though there are exceptions to this), and upon standing for some time, an iridescent pellicle is frequently formed upon its surface, which upon examination proves to be crystallized, and is composed chiefly of the salt in question. Minute crystals of the same salt also frequently attach themselves to the sides of the vessel in which the urine has stood for a short time. Urine abounding in this salt is often of considerable specific gravity, contains abundance of urea, and is very apt to become alkaline and putrescent. Sometimes, on the contrary, the specific gravity is lower than natural. When this salt abounds very much, the crystallized deposite is formed before the urine is discharged from the bladder, and consequently immediately subsides to the bottom of the vessel in which it is passed; in this case the urine is alkaline when voided; most generally, however, the crystals do not begin to form till the urine has become cool, and sometimes not till it has begun to putrify; and these circumstances indicating the periods when the urine becomes alkaline, may be considered as pointing out the degree of severity of the disease.

With respect to the causes of this form of deposite, they resemble, or, perhaps, may be identical in all respects with those occasioning the deposition of the amorphous sediments to be detailed in the next paragraph. They are, however, frequently much slighter in degree; thus any thing acting generally and producing *a nervous state of the system*, such as the distressing passions, and particularly *mental anxiety* or *fear*, will frequently produce in many people an excess of this salt in the urine. The same is also true of many articles of food or medicine that produce a hurried secretion of the urine, and act as diuretics; as the neutral salts in some cases, and particularly the Rochelle salts and other saline compounds, in which the acid is of vegetable origin. So also a long continued use of alkaline remedies, or of mercury, in irritable habits more especially, will likewise produce a tendency to an excess of this salt, as well as of the phosphates in general, and even lead to an actual deposition of them from the urine. The same sediment also frequently abounds, or is easily induced in the urine of those who have long been in bad health, and in whom the constitution may be considered as giving way, or, to use a common expression, breaking up. In general it is to be understood that the slighter causes affect only the predisposed, and those in particular who are subject to other diseases of the urinary organs or urine. It may be also remarked, that children are more subject to this form of deposition than adults; a circumstance, perhaps, to be referred to the irritability of the system at this age, and the great derangement of the digestive organs, to which they are subject.

The prognosis, in this form of disease, will entirely depend on its cause and permanency. When it occurs but seldom, and from any of the minor circumstances above-mentioned, it is usually only temporary, and of little importance. But when it takes place in advanced life, or is connected with organic disease; or when the recurrence is very frequent from the slightest causes, there is much more danger; and the latter in particular shows a tendency to the affection, which those who are liable to it will do well to look to, least it should become permanent, in which state it is not easily conquered.

II. *Of amorphous sediments composed of the phosphates.* These sediments consist invariably of a mixture of the phosphate of lime, and of the triple phosphate of magnesia and ammonia.* The proportions of the two salts vary very much in different instances; but sometimes the phosphate of lime seems to constitute by far the greater proportion, and in this case the symptoms are commonly much more decided and severe; and it is to this form of the disease, that the following observations are to be understood as chiefly applicable.

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* I am aware that it is the opinion of many eminent characters, that the inner coat of the bladder is the source of the earthy matters deposited by the urine on these occasions. I do not deny this altogether; but, on the contrary, think that the phosphate of lime at least, is sometimes partly derived from this source—the inner coat of the bladder apparently assuming in such instances, the character of the inner surface of the abscess sometimes found in the prostate gland, which is known to secrete this earthy salt in great abundance. I am doubtful, however, if any portion of the triple phosphate is ever derived from this source, but from the kidney only, from which same source in various cases a large proportion of the phosphate of lime is likewise undoubtedly derived.

A deposition of the earthy phosphates from the urine has been long observed to be attended by very distressing symptoms, though no one seems to have hitherto generalized them. They consist in great irritability of the system, and, derangement of the chylopoietic viscera in general; such as flatulency and nausea, obstinate costiveness, or peculiarly debilitating diarrhœa, or both frequently alternating; and the stools are extremely unnatural, being either nearly black, or clay-coloured, or sometimes like yeast. These are always accompanied by more or less of a sensation of pain, uneasiness, or weakness, in the back and loins. There is a sallow, haggard expression of countenance; and as the disease proceeds, symptoms somewhat analogous to those of diabetes, begin to appear, such as great languor and depression of spirits, coldness of the legs, complete anaphrodisia, and other symptoms of extreme debility: and the disease, if not speedily checked, seems capable of ending fatally. The urine in this form of disease is invariably pale coloured, and, upon the whole, voided in greater quantity than natural. Sometimes (generally, I think, by day), it is voided in very profuse abundance; and in this case is of very low specific gravity; 1·001 or 1·002, for example.* At other times it is voided in less quantity, and its specific gravity is proportionally higher, but it is seldom very high; that is, surpassing 1·025. In the former case it is generally perfectly pellucid and colourless, and deposits no sediment; in the latter, it is sometimes opake when passed, and always after standing for a greater or less time, deposits a most copious precipitate of the mixed phosphates, in the state of an impalpable powder. In all cases the urine is extremely prone to decomposition, becomes alkaline by the evolution of ammonia, and emits a most disgusting smell. To those who have never seen this condition of the urine, the above will probably furnish but an imperfect idea. I trust, however, that the description will enable any one to distinguish such urine when they see it; and when they have once paid attention to its properties, they will afterwards readily recognize it.

With respect to the causes of this complaint, they may be either general or local; for the most part, however, they seem to partake of both characters.

A large proportion of those cases, which have come under my own observation, has been distinctly traced *to some injury of the back.* This injury has been of a character not very capable of being understood or described; but perhaps some idea of it may be acquired by my stating, that for the most part it has arisen from a fall from a horse, in which the person has received a violent general concussion of the spine, and often at the same time some local injury about the back, but not of such a nature as to confine him long, or to lead him to think that he has received any material injury; and generally it has been quite forgotten till the patient's attention has been called to the subject.* Among the general exciting causes may be also mentioned, severe and protracted debilitating passions, excessive fatigue, &c. The local causes are, generally some irritation about the bladder, or urethra, especially when operating constantly for a considerable length of time; as, for example, any foreign substance introduced into the bladder and producing irritation of that organ, including all sorts of calculi under certain circumstances; the retaining of a bougie or catheter in the urethra; strictures of the urethra in some rare cases, and in particular constitutions; all which, and many other similar causes, are capable of producing, in a greater or less degree, a condition of the urine more or less resembling that above described, and readily depositing the phosphates. Thus, it has been long known that any foreign substance introduced into the bladder almost invariably becomes incrusted with the phosphates, and not the lithic acid.*

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* This is one of the forms of *diuresis*, in which the *increased* flow of urine is not *constant*, but takes place at certain times only, either spontaneously, or from the slightest exciting causes: so that, upon the whole, the quantity voided is generally greater (often much greater) than natural.

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* I have never had an opportunity of inspecting a body after death under these circumstances: perhaps this would throw some light upon the subject. It is, I believe, a very old observation, that injuries of the back produce *alkaline urine;* yet what is surprising, no one seems to have thought of applying the remark to the present form of disease. This appears also to hold in other animals as well as man; thus, I have frequently observed jaded and worn out horses pass great quantities of lime in their urine: I have known the same also to take place in dogs, and particularly of the sporting kinds; and in both these instances have thought it probable, that the circumstance was connected with some strain or injury of the back produced by over exertion, or other causes.

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With respect to the proximate cause of this form of disease, we may suppose it to consist in a diminished or suspended action of the usual acidifying powers of the kidneys, and the formation, instead of lithic acid, of a greater quantity of alkaline matter than natural, as urea (equivalent to ammonia), and particularly of magnesia and lime; but this being little more than a simple expression of obvious facts, of course throws no light upon the immediate cause of these depraved actions.

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With respect to the causes of this form of deposite, they resemble, or, perhaps, may be identical in all respects with those occasioning the deposition of the amorphous sediments to be detailed in the next paragraph. They are, however, frequently much slighter in degree; thus any thing acting generally and producing *a nervous state of the system,* such as the distressing passions, and particularly *mental anxiety* or *fear,* will frequently produce in many people an excess of this salt in the urine. The same is also true of many articles of food or medicine that produce a hurried secretion of the urine, and act as diuretics; as the neutral salts in some cases, and particularly the Rochelle salts and other saline compounds, in which the acid is of vegetable origin. So also a long continued use of alkaline remedies, or of mercury, in irritable habits more especially, will likewise produce a tendency to an excess of this salt, as well as of the phosphates in general, and even lead to an actual deposition of them from the urine. The same sediment also frequently abounds, or is easily induced in the urine of those who have long been in bad health, and in whom the constitution may be considered as giving way, or, to use a common expression, breaking up. In general it is to be understood that the slighter causes affect only the predisposed, and those in particular who are subject to other diseases of the urinary organs or urine. It may be also remarked, that children are more subject to this form of deposition than adults; a circumstance, perhaps, to be referred to the irritability of the system at this age, and the great derangement of the digestive organs, to which they are subject.

The prognosis, in this form of disease, will entirely depend on its cause and permanency. When it occurs but seldom, and from any of the minor circumstances above-mentioned, it is usually only temporary, and of little importance. But when it takes place in advanced life, or is connected with organic disease; or when the recurrence is very frequent from the slightest causes, there is much more danger; and the latter in particular shows a tendency to the affection, which those who are liable to it will do well to look to, least it should become permanent, in which state it is not easily conquered.

II. *Of amorphous sediments composed of the phosphates.* These sediments consist invariably of a mixture of the phosphate of lime, and of the triple phosphate of magnesia and ammonia.* The proportions of the two salts vary very much in different instances; but sometimes the phosphate of lime seems to constitute by far the greater proportion, and in this case the symptoms are commonly much more decided and severe; and it is to this form of the disease, that the following observations are to be understood as chiefly applicable.

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* I am aware that it is the opinion of many eminent characters, that the inner coat of the bladder is the source of the earthy matters deposited by the urine on these occasions. I do not deny this altogether; but, on the contrary, think that the phosphate of lime at least, is sometimes partly derived from this source—the inner coat of the bladder apparently assuming in such instances, the character of the inner surface of the abscess sometimes found in the prostate gland, which is known to secrete this earthy salt in great abundance. I am doubtful, however, if any portion of the triple phosphate is ever derived from this source, but from the kidney only, from which same source in various cases a large proportion of the phosphate of lime is likewise undoubtedly derived.

A deposition of the earthy phosphates from the urine has been long observed to be attended by very distressing symptoms, though no one seems to have hitherto generalized them. They consist in great irritability of the system, and, derangement of the chylopoietic viscera in general; such as flatulency and nausea, obstinate costiveness, or peculiarly debilitating diarrhœa, or both frequently alternating; and the stools are extremely unnatural, being either nearly black, or clay-coloured, or sometimes like yeast. These are always accompanied by more or less of a sensation of pain, uneasiness, or weakness, in the back and loins. There is a sallow, haggard expression of countenance; and as the disease proceeds, symptoms somewhat analogous to those of diabetes, begin to appear, such as great languor and depression of spirits, coldness of the legs, complete anaphrodisia, and other symptoms of extreme debility: and the disease, if not speedily checked, seems capable of ending fatally. The urine in this form of disease is invariably pale coloured, and, upon the whole, voided in greater quantity than natural. Sometimes (generally, I think, by day), it is voided in very profuse abundance; and in this case is of very low specific gravity; 1·001 or 1·002, for example.* At other times it is voided in less quantity, and its specific gravity is proportionally higher, but it is seldom very high; that is, surpassing 1·025. In the former case it is generally perfectly pellucid and colourless, and deposits no sediment; in the latter, it is sometimes opake when passed, and always after standing for a greater or less time, deposits a most copious precipitate of the mixed phosphates, in the state of an impalpable powder. In all cases the urine is extremely prone to decomposition, becomes alkaline by the evolution of ammonia, and emits a most disgusting smell. To those who have never seen this condition of the urine, the above will probably furnish but an imperfect idea. I trust, however, that the description will enable any one to distinguish such urine when they see it; and when they have once paid attention to its properties, they will afterwards readily recognize it.

With respect to the causes of this complaint, they may be either general or local; for the most part, however, they seem to partake of both characters.

A large proportion of those cases, which have come under my own observation, has been distinctly traced *to some injury of the back.* This injury has been of a character not very capable of being understood or described; but perhaps some idea of it may be acquired by my stating, that for the most part it has arisen from a fall from a horse, in which the person has received a violent general concussion of the spine, and often at the same time some local injury about the back, but not of such a nature as to confine him long, or to lead him to think that he has received any material injury; and generally it has been quite forgotten till the patient's attention has been called to the subject.* Among the general exciting causes may be also mentioned, severe and protracted debilitating passions, excessive fatigue, &c. The local causes are, generally some irritation about the bladder, or urethra, especially when operating constantly for a considerable length of time; as, for example, any foreign substance introduced into the bladder and producing irritation of that organ, including all sorts of calculi under certain circumstances; the retaining of a bougie or catheter in the urethra; strictures of the urethra in some rare cases, and in particular constitutions; all which, and many other similar causes, are capable of producing, in a greater or less degree, a condition of the urine more or less resembling that above described, and readily depositing the phosphates. Thus, it has been long known that any foreign substance introduced into the bladder almost invariably becomes incrusted with the phosphates, and not the lithic acid.*

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* This is one of the forms of *diuresis*, in which the *increased* flow of urine is not *constant*, but takes place at certain times only, either spontaneously, or from the slightest exciting causes: so that, upon the whole, the quantity voided is generally greater (often much greater) than natural.

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Alkaline remedies of every description must be most carefully avoided, their use in every point of view being most mischievous when the phosphates are concerned. Indeed all remedies that act as diuretics should, in general, be shunned, and the patient should be prohibited from drinking too much. With respect to drinks, in general, they should be of a soothing demulcent character, and prepared with distilled or the softest water that can be procured, as hard waters are literally poison in this form of disease.

In less severe cases, where the source of irritation is chiefly confined to the urinary organs, and where the constitution is sound, and the strength not remarkably reduced, similar means may be had recourse to; though opium to the above extent is seldom necessary or proper. In such cases the hyoscyamus is an excellent remedy, especially when combined with the extract of *uva ursi,** and more or less, according to circumstances, of the *extr. opii.* The same is true of the *alchemilla arvensis,* a strong infusion of which taken frequently, sometimes gives great relief. In such cases also, occasional purgatives, especially those of the milder class, may be employed with safety and advantage. Indeed in some of the diseases of children, in which the triple phosphate in particular is copiously deposited, repeated purgative doses of calomel and rhubarb are of the utmost utility. These diseases may be commonly distinguished by the absence of the severe symptoms above-mentioned, and by the high specific gravity of the urine.

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* For some time past I have been in the habit of giving this preparation of the uva ursi, which I had made for the purpose, with the best effect. The powdered leaves of this plant are so bulky and disagreeable, that few stomachs will bear to persevere long enough in the use of the requisite quantity; and the same is pretty much the case with the infusion and decoction. Hence this plant has fallen to disuse; but certainly, in my opinion, undeservedly, as it undoubtedly possesses considerable powers in chronic affections of the bladder, *for which only it is adapted,* its operation being slow, and requiring perseverance.

The *diet* in severe cases should be of the mildest and most nutritious kind, and taken in very moderate quantities at a time. From what I have seen, I am certainly inclined to advise an animal diet in preference to an acescent vegetable diet, commonly recommended; but I wish it to be understood, that no positive directions are given on this point, which is left to be determined by future observations, or rather, perhaps, by the circumstances of the patient; for I am disposed to believe, that in all instances, that diet is most proper for a patient, which agrees best with him, and which in many instances can be only known by actual trial; I may give it, however, as my opinion, that all watery diet, as soups, &c. should be taken very moderately. If the patient has been accustomed to wine, the Rhine, or some of the lighter varieties of French wines, will be preferable. Cider and perry may be also taken, if they do not disagree. I wish it to be understood, however, that the use of these is not particularly recommended.

But these, and every thing else that can be done for a patient in this state, are of very little use, if the *mind* cannot be set at rest. The influence of mental anxiety is really astonishing in this disease; and absence from care, the exhilarating air of the country, and such exercises as are consistent with the patient's condition, will, perhaps, more than any thing else, contribute to the cure, particularly in the slighter cases, and when the cause is not local injury.

The first form of the disease in some of its varieties is so common, that I do not think it worth while to illustrate it by reciting cases. The second form is much more rare; and when it does occur, is most generally complicated with stone in the bladder, to which most of the distressing symptoms have in consequence been referred. To show, however, that such a disease exists independently of stone in the bladder, I shall relate one or two cases illustrating this point.

Case 1. Aug. 14, 1820.—J. E. Joiner, aged 42, has been a sailor; and 19 years ago, when on board a ship, got a fall upon his back, which particularly affected the left side, about the region of the loins. This fall confined him three months on crutches; but he afterwards, as he supposed, got completely well; though every spring or summer since that period, he has always suffered more or less, and for a greater or less time, with pain in the loins. The present attack commenced 18 months ago in the usual manner, but with greater severity, and has continued more or less ever since. Till within these four months, however, he had not been led to observe any thing peculiar in his urine, but had been only annoyed with the usual painful symptoms and weakness in the back. At this time, the quantity of water began to increase very much; and he observed it to deposit occasionally a very large quantity of white earthy matter. Under these circumstances he went to a dispensary, where his disease appears to have been considered as diabetes, and treated accordingly, but without any advantage. His symptoms at present are severe enervating pains in the region of the loins, extending round to the groin and lower part of the abdomen, and occasionally down the thighs and legs, accompanied by retraction and soreness of the testes. Occasionally also he suffers excruciating pains in the head, affecting his sight. All these symptoms, however, are much worse on certain days than others, and the worse symptoms are usually accompanied by diarrhœa. Latterly, he has become much thinner than usual; his appetite has fallen off; he sweats on the least exertion; and among other symptoms of debility, has complete anaphrodisia. He is thirsty, his tongue is clean and redder than usual, he is troubled with flatulency, and his bowels are very irregular. The state of his urine also is very variable: what he passes first in the morning, and perhaps once more in some other part of the day, is at first commonly transparent, and of a light yellow colour, but soon deposits a sort of mucous cloud, which in a few hours becomes converted into a perfectly white earthy matter. The specimen of the urine of this description which he brought with him, was contained in a two-ounce phial. Its specific gravity was 1·0234; and the earthy matter, when it was allowed to stand for some time, occupied nearly ⅓ of the height of the bottle. It was in the form of a fine white powder, and was found to consist of the mixed phosphates. This urine when first voided reddened litmus paper; and contained a large proportion of urea, and fully the usual quantity of pale coloured lithic acid. At other periods of the day, and particularly during the morning, he is conscious of a sense of tightness or fulness of the abdomen, from which he is relieved by voiding large quantities of a limpid colourless urine, nearly free from all sediment. I had likewise an opportunity of examining a specimen of this, and found it exactly resembling the first in its properties, except that it was much more watery, and its specific gravity was only 1·0064. The urine had a disagreeable smell, and was very prone to putrefaction, in which state the smell emitted was peculiarly offensive. It may be also observed, that it was passed without any difficulty, or urgent desire, except what arose from its quantity, which he supposed amounted in twenty-four hours to four or five quarts.

Ordered, *pil. sap. c. opio, gr. v. bis die.*

August 22. Found instant relief from pain after taking the pills; urine reduced to three quarts in twenty-four hours. States that the white sediment has nearly disappeared; complains of being very costive. On examining the urine voided yesterday morning, its specific gravity was found to be 1·0137, and there was only a slight deposite of the earthy phosphates; but its properties in other respects were nearly as before. The urine voided this day at six in the evening, was almost perfectly colourless and transparent, and had a specific gravity of only 1·0027.

Contr. pil. sap. c. opio, gr. v. ter die. Take tomorrow morning Ol. Ricini ℥i.

28. The castor oil affected the bowels moderately, and afforded him some relief. Continues tolerably free from pain. The urine voided in my presence, at six o'clock in the evening, did not differ in appearance and specific gravity from *common spring water*, though it still emitted the same offensive smell as formerly in a less degree.

29. Felt better for three days after I last saw him; the urine had diminished in quantity, and the white deposite entirely disappeared. For the three last days the pain has returned, and the urine has increased in quantity. What was passed this morning had a specific gravity of 1·0242, and deposited a very copious mucous cloud, but no earthy sediment. The urea was excessive.

Ordered, *pil. sap. c. opio. gr. x. ter die.*

Sept. 2. Feels a great deal better. Little or no pain for the last three days. His urine deposits no white sediment, and he passes only a little of the clear urine in the forenoon, the whole amounting in twenty-four hours to two quarts. The specific gravity of what was passed this morning was 1·0201, and it contained an excess of urea. He has been costive for the last few days.

Contr. pil. sap. c. opio, gr. x. ter. die. Take to-morrow morning Ol. Ricini ℥i.

12. Almost quite free from pain; and tried in consequence to resume his work, but was obliged to desist on account of a distressing sense of weakness in his back. His appetite is much improved: he sweats less than usual, and is not sleepy. Rather costive. Urine reduced to two quarts in twenty-four hours; specific gravity of that voided in the morning 1.0174.

Ordered, *pil. sap. c. opio, gr. x. in the morning and at noon, and gr. xv. at bed time.* He was also ordered *to take to-morrow morning, Ol. Ricini ℥i. and apply a large pitch plaster to the loins.*

September 19. Took the castor oil, which induced a diarrhœa that lasted for two or three days, during which time his pain returned. It was less severe, however, in the back than usual, and was accompanied by a peculiar sense of coldness and weakness in the calves of the legs. Has now recovered from the diarrhœa and all the other symptoms, and has not felt so well for many months. Urine in twenty-four hours about two quarts, and quite free from earthy sediment. Specific gravity of that voided this morning 1·0207.

Contr. pil. sap. c. opio, gr. x. ter die.

November 30, I saw this poor man again, and was happy to hear that he had continued quite well from the last date, and had followed his work as usual, having taken the opiate pills occasionally. He had recovered his usual strength, &c. and his urine now abounded with the lithate of ammonia.

In September 1822, nearly two years after the above date, I learned that this patient had remained quite free from his complaint, and was then so well in all respects as to be able to follow his work as usual. But I suspect the presence of some organic disease, which will sooner or later prove fatal.

The only case on record that I am at present acquainted with, equal to the above in severity, is one summarily described by Dr. Henry as follows: *

Case 2. " Several years ago, the Rev. Mr. R——, of Cheadle, in Staffordshire, consulted me respecting a train of very distressing symptoms, some of which evidently denoted considerable disease in the kidneys. His urine, which at some times was perfectly limpid, was at others loaded with a white substance, which gave it, when first voided, the opacity of milk. On standing, a copious deposite took place, a portion of which was sent me for examination. It was perfectly white, and so impalpable as to resemble a chemi-

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* Med. Chirurg. Trans. x. p. 139. There are also two cases somewhat similar in Dr. Rollo's Treatise on Diabetes, p. 424, second edition. Both these cases were produced by *injuries of the back*, and were considered to be of a *diabetic* nature. The deposition of the phosphates is not indeed mentioned; but, as this is a symptom not constantly present in these affections, the circumstance might have been overlooked, particularly as the attention was otherwise directed.

cal precipitate. On analysis, it proved to consist of nearly equal parts of the triple phosphate and phosphate of lime. The discharge of this powder was always preceded by violent attacks of sickness and vomiting; and its quantity was invariably increased whenever he took soda-water, or any other alkaline medicines. Besides the affection of the kidneys, there appeared to me to exist important disease of the chylopoietic viscera; and to this I ascribe his death, which took place a few months afterwards. In this case it was remarkable that the weight of the body was reduced from 183 pounds to 100 pounds, at rather an early stage of the disease, without a corresponding degree of muscular emaciation." No one can doubt, I think, that this case differs from the preceding except in degree; and it is to be regretted that we know so little about it—particularly its cause.

Case 3. I am induced to give an abstract of the following interesting case in this place, because it not only illustrates, in a very striking manner, the pathology of this form of disease, but also several collateral points connected with the subject in general.

Master S. the subject of the following history, was operated on for the stone in the bladder when he was in the eleventh year of his age, by an eminent surgeon in the city. Some fragments of this calculus, which I saw, consisted chiefly of the lithate of ammonia, and have been described by me elsewhere. He suffered a good deal from the operation, but at length recovered, and continued well for twelve months, when he was seized at school with irritation in making water, and returned from thence at Christmas, 1819, with all the symptoms of stone in the bladder a second time. At this period he was examined repeatedly by the surgeon who had operated on him, but no stone was found, except on one occasion, when he thought he felt it indistinctly. I saw Master S. for the first time on the 7th of July, 1820, about a fortnight previously to which time he had been seized with vomiting and diarrhœa, which had reduced him considerably. When I first visited him the diarrhœa still continued in some degree, and the pulse was quick and irritable. He complained of great pain in the seat of the wound, but passed a good deal of urine without much difficulty. The specific gravity of the urine was 1006·1, it was pale-coloured and opake, and on standing deposited a large quantity of a tough ropy mucus. It very faintly reddened litmus paper when first passed, but soon became opalescent, and deposited the triple phosphate of magnesia and ammonia in abundance. Some palliatives were ordered; but as there was every reason to suspect the presence of stone in the bladder, it was recommended that a surgeon should be consulted, and that if stone was found, this should be extracted as speedily as circumstances would admit. The palliatives, as was expected, gave only temporary relief; and a surgeon was called in, who, on sounding, immediately found a stone. The operation was performed on the 30th of July, and a calculus consisting chiefly of the triple phosphate of magnesia and ammonia, and weighing 252¼ grs. was extracted. He bore the operation well, and every thing went on favourably.

August 3. Doing extremely well. Urine pale-coloured, opake and slightly tinged with blood. Specific gravity 1008·3, rather copious sediment; became strongly alkaline in a few days.

—— 10. Going on well in all respects. Urine very slightly opake. Specific gravity 1010·2, peculiar smell, and slightly albuminous. Slightly acid when voided, but soon became fœtid and alkaline.

—— 28. Quite well from operation, and placed under my care. Urine pale-coloured, specific gravity 1010·7. Peculiar smell, and deposits a mucous sediment mixed with the phosphates on standing. Ordered *infusi cinchonæ* ℥viii. *acidi muriatici* ♏. xl. *tinct. opii*, ♏. xxx. Two large table-spoonfuls to be taken thrice a day. Bowels to be regulated by castor oil, if necessary.

September 5. Urine pale coloured, and rather more copious than natural: specific gravity 1009·4, contains very little mucus, and is less offensive. Feels much stronger and better. *Acid. mur.* to be increased to ♏. lx. and *tinct. opii* to ♏. l.

—— 14. Urine pale coloured, and very slightly opalescent: specific gravity 1010·7: reddens litmus, and is not affected by boiling. Appetite good. Feels strong and well, and walked to my house, a distance of nearly three miles, for the first time. The medicines to be continued as above.

Sept. 22. Urine pale-coloured: specific gravity 1011·8. Quantity about three pints daily. Scarcely leaves a sensible deposite in the glass after standing a whole week. Feels strong and well. To continue the medicines as before.

——— 30. Urine rather deeper coloured than usual: specific gravity 1011: some triple phosphate crystals deposited. Has taken the medicines only twice a day for the last week.

October 9. Urine contains more of the phosphates than usual: specific gravity 1012·9: suffers some irritation in the bladder. Has been at school for the last week. Ordered to resume the medicines thrice a day.

——— 15. Urine deeper coloured than before: specific gravity 1012·9, with less of mucous deposite. Feels better. Continue the medicines.

From this time, under the plan above-mentioned, which was strictly attended to, he continued on the whole to improve, evidently grew fast, and appeared in good health.

April 1, 1821. Urine for the last month has deposited abundance of pale coloured lithic acid; at present rather deep coloured and transparent; but on standing some time becomes opake, and deposites triple phosphate crystals: specific gravity 1015·3. Feels well. Under these circumstances I wished to ascertain if medicines could be dispensed with: he was therefore ordered to omit the *acid. mur.* and *tinct. opii*, and continue the *infusum cinchonæ* alone.

—— 4. Immediately after omitting the medicines a sediment began to appear in the urine, and he felt more irritation. Urine passed this morning *strongly alkaline, and deposits an immense quantity of the mixed phosphates*. Medicines as before ordered to be resumed immediately.

—— 8. *Sediments disappeared as soon as the medicines were resumed*, yet the pain and uneasiness still continue in some degree.

May 13. Recovered since the last date, and remained well till within the last two or three days, when he became irritable, and unable to hold his water; ascribes this to a blow he accidentally received on his back just before that time. Urine at present rather pale-coloured: specific gravity 1017, soon becomes alkaline and deposits a very large proportion of the mixed phosphates. Medicines to be continued as before.

June 10. Walked ten miles yesterday and felt fatigued. Urine of this morning alkalescent, with considerable deposition of the phosphates: specific gravity 1020·6. Before this walk he had seen no deposite for some time.

July 29. Urine transparent and free from sediment: sp. gr. 1013·4: for the last two or three days has been subject to slight incontinence of urine, having been absent from school, and taking more violent exercise than usual. From this time till December 22, 1822, the symptoms continued very much the same as above-mentioned, though upon the whole gradually improving, the medicines being regularly persisted in.

January 26, 1823. Specific gravity of the urine 1016·7. Rather deep coloured; but on standing deposits a little of the triple phosphate. Has felt strong and well latterly. From this time till August 29, 1824, he continued on the whole to improve, the medicines being still regularly persisted in till within the last two or three months, when he felt himself so well as to be able to omit them once in the day, and sometimes for a whole day together, without inconvenience. Has grown remarkably tall and stout lately. At the above date the specific gravity of the urine was 1019, and it reddened litmus when passed, but became alkaline on standing, and deposited some pale-coloured lithate of ammonia. For the last five or six months has been taking an infusion of *uva ursi*, acidulated with *muriatic acid*, and conjoined with a little *pulv. ipecac. comp.*

November 28, 1824. Has continued well since the last date, the medicines having been never taken more than twice a day, and sometimes entirely omitted. Has occasional pains in the back, but is otherwise strong and well. Specific gravity of the urine 1018·5, and neutral, with some mucous deposite, and a little of the triple phosphate of magnesia and ammonia. He now thought himself so well as to be able to leave off medicine altogether; but this was deemed imprudent, and he was recommended to persevere at least till the spring.

This case, while it demonstrates unequivocally the influence of medicines, in warding off the effects of the disease, at the same time shows the necessity of perseverance. Had the use of medicines not been regularly persisted in, there can be little doubt that this unfortunate youth would have repeatedly suffered again from the stone in the bladder; but I hope now, from the improvement that has lately taken place, that this dreadful occurrence will be prevented, and that he will ultimately recover.

Case 4. The following case I relate principally with the view of illustrating an opinion I have advanced, that the deposition of the phosphates is rather to be considered as indicating an increased secretion of earthy matter, than of the phosphoric acid.—The patient was a gentleman between thirty and forty years of age, who had for several years laboured under stricture of the urethra (acquired, I believe, in the usual manner), for which he had consulted an eminent surgeon, and obtained much relief. He never considered it, however, as entirely removed, and was in the habit of occasionally introducing a bougie himself. Latterly, the irritation had become greater than usual, especially at the moment of passing the last portions of urine, and for some time afterwards; and he now observed that he passed at this time a very considerable portion of white earthy matter, mixed with mucus. At length he voided one or two small calculi composed of the same earthy matter, which gave him the alarm, and induced him to apply for medical advice. His countenance was sallow and unhealthy, and the functions of the digestive organs evidently deranged; but in other respects there was nothing remarkable. The earthy matter, and particularly the small calculi, consisted almost entirely of the *carbonate of lime,* mixed with a small proportion of the earthy phosphates. He was ordered an alterative pill composed of the pil. hydrarg. and ext. of gentian, and to take the muriatic acid three times a day. The acid, however, disagreed so much with him, that he was obliged to leave it off immediately. Nothing else was ordered; but he took a little respite from the fatigues of business, and went into the country, from whence he returned in the course of a few weeks, perfectly well, and has had no return of the affection since. It may be also remarked, that the symptoms of irritation in the urethra ascribed to the stricture subsided with the disappearance of the earthy matter.

In this case the secretion of lime without phosphoric acid was remarkable—even the absence of phosphoric acid in the usual proportion may, I think, be inferred; for if it had been present, it is difficult to conceive why it should not have combined with the lime. This case is also interesting, inasmuch as it seems to show, that a mere irritation in the urethra, in certain constitutions, and in certain states of the general health, will produce a tendency to the disease in question.

In conclusion, perhaps it may not be deemed superfluous to draw the attention of the reader once more to the important facts already mentioned, and sufficiently established by these cases: namely, that although all the other forms of urinary deposition converge, as it were, towards the formidable state of disease we have been considering, (which may, therefore, be viewed as the last and worst state of things;) yet if the original cause of irritation can be mitigated or removed, a healthy state of the urine may be again reproduced, and the patient will thus recover. But on the other hand, if this cause be of such a nature that it cannot be mitigated or removed; or if the disease when once fairly established be permitted to proceed unchecked, or be combatted by inefficient or irrelevant treatment, the patient will be doomed to much misery, and his recovery will be exceedingly doubtful.

II. OF MECHANICAL AND ORGANIC DISEASES OF THE URINARY ORGANS.

CHAP. I.

Of the Symptoms and Treatment of Urinary Calculi when lodged in the Kidney and Bladder, with Observations on other Affections of the Urinary Organs, occasionally produced by, or liable to be mistaken for Calculous Affections, and on the Importance of attending to the State of the Urine in these Affections.

ORGANIC diseases of the urinary organs are so intimately connected with calculous affections, and so liable to be mistaken for them, that without some remarks on the subject the present volume might be considered as incomplete. For obvious reasons it is not my intention to enter deeply into details, but to present such a view of the principal diseases, and of the conditions of the urine with which they are associated, as shall, I trust, not only lead to a more ready discrimination between them, but in some instances to a more satisfactory mode of treatment. For this purpose the subject will be considered under two general heads:—I. Calculous and other affections of the kidney and ureter; and, II. Calculous and other affections of the bladder and prostate gland. The diseases of the urethra in general fall so decidedly within the province of the surgeon, that I do not deem it necessary to enter on this part of the subject.

SECT. I.—*Calculous and other Affections of the Kidney and Ureter.*

1. *Calculus in the Kidney and Ureter, &c.*—In a former chapter we attempted to point out the circumstances under which the lithic acid calculus, which is by far the most frequent, is formed in the kidney, and we have now to consider the symptoms, &c. produced by calculi in general, when operating as mechanical agents upon that organ and the ureter, and at the same time to endeavour to throw some additional light on their general formation.*

At a greater or less period after the active symptoms, formerly described, have subsided, and the flow of urine has begun to assume its natural course, the stone, in favourable circumstances, quits the kidney, and the patient, who had never, perhaps, since the attack been perfectly free from an uneasy sensation in the back, now feels a sudden and very acute pain in the region of the kidney, accompanied at first by nausea, and soon followed, for the most part, by violent sickness and vomiting, and a great accession of fever. The pain as it proceeds, extends forwards, and is felt in the groin, and down the inner part of the thigh, and is commonly attended by painful retraction of the testicle on the same side. The urine at the same time becomes high coloured, small in quantity, and often mixed with blood. These distressing symptoms go on increasing for a greater or less time, and at length, in favourable circumstances, terminate as suddenly as they began the moment the calculus quits the ureter and enters the bladder, which commonly happens during a violent fit of vomiting, and with a more than ordinarily severe paroxysm of pain, which the patient compares to that of stabbing.

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* See chap. vi. p. 136.

Such are the usual symptoms of the passage of a small urinary calculus from the kidney to the bladder; there are, however, instances on record, and I have seen one or two such, in which calculi of very considerable magnitude have passed down the ureter without producing severe symptoms, and even in some instances without the apparent consciousness of the patient; but such instances are rare, and, according to my experience hitherto, confined to the mulberry variety of calculus.

The sudden cessation of the pain and other symptoms, indicate, as before observed, the arrival of the little calculus into the bladder, from which it is sometimes voided instantly without any trouble; or what is most usual it is retained for a few days, till all irritation of the urinary organs has subsided, when it comes away unexpectedly. In some unfortunate cases, however, the little stone is retained so long in the bladder as to become much increased in size, and rendered incapable of passing off by the urethra—thus constituting the nucleus of a vesical calculus, the symptoms attending which will be considered in the next section.

Sometimes the stone originally formed in the kidney, from its magnitude, or from other unfavourable circumstances, does not descend by the ureter in the manner above-mentioned, but is retained in that organ, when it gives origin to a long train of symptoms of a chronic character, and usually of a very distressing kind, that for the most part only terminates with the life of the patient. The most frequent of these is a constant sense of weight or uneasiness in the lumbar region, which is apt to be much increased by exercise, and particularly by riding on horseback, or in a rough carriage. There is also occasionally pain and retraction of the testicles, and a sensation of numbness extending down the inside of the thighs, with a variety of other anomalous sensations, apparently of a nervous character, in various parts of the body, and particularly in the stomach and urinary organs. Not unfrequently also the urine is rendered bloody, or purulent, by a discharge of these fluids from the diseased organ, particularly after exercise; and moreover is generally loaded with amorphous sediments, or gravel, especially if the prevalent diathesis be of the lithic kind.

In some unfortunate cases the calculus in descending from the kidney becomes permanently retained in the contracted part of the ureter; thus producing a series of symptoms, so nearly resembling those above related, as to be with difficulty distinguished from them (except perhaps that in general they are more acute), and, like them, generally terminating in the disorganisation of the kidney, &c. and finally the death of the patient. Before, however, we proceed to consider the organic affections of the kidney produced by these and other causes, an attempt will be made to throw some additional light on the formation of renal calculi.

It has been already stated, that lithic acid nuclei are most liable to be formed in those whose urine ordinarily deposits this principle in the form of crystallized sediments or gravel, and at those periods of gout, fever, &c. when amorphous sediments are also liable to be formed, and when the watery portion of the urine is for the most part much diminished relatively to the saline and other ingredients. The truth of these remarks, I presume, must be so obvious, as to require no illustration: but it must be equally obvious that these cannot be the *only* circumstances connected with the formation of calculous nuclei; for if they were, these affections must be infinitely more frequent than they are, since the occurrence of such conditions of the urine as those above described is by no means uncommon. The fact is, that although the above conditions of the urine and health strongly predispose, and are even necessary to the deposition of the nuclei, the presence of other circumstances are likewise required for their immediate formation. Some of these circumstances may be occasional and purely accidental; but, generally, it is probable that they are the result of disease, and somewhat analogous to the following:

The kidney is made up of a congeries of similar parts, or little kidneys, if we may use the expression, each one of which is independent of the others in its structure, and may therefore, probably, independently of the others, become more or less deranged in its functions. Let us suppose one or more of these little kidneys similarly deranged to the others, but in a greater degree, so as to secrete very little water, but a large proportion of lithic acid. In such a case the lithic acid must be obviously separated in that peculiar semi-fluid condition, or state of hydrate,* which it is well known to be readily capable of assuming. In this state it is bulky, and may thus occupy the whole of the infundibulum in which it has been deposited; or the quantity may be supposed to be sometimes so great as to be partly protruded, in a similar state, into the common receptacle or pelvis of the kidney. After remaining in this state for a greater or less time, crystallization may be supposed to take place; the semi-fluid mass will now be much diminished in bulk, and perhaps reduced to the form of a congeries of crystals easily separable from one another, and thus pass off in the form of gravel; or, what may easily be supposed to take place, (especially when the lithic acid is very impure, and combined with a larger portion of other matters than usual,) it may assume the form of an imperfectly crystallized or amorphous mass, and thus constitute a nucleus possessing these characters; or something between these two extremes may take place—the plastic mass may separate partly into crystals, and partly remain an amorphous mass, enveloping those crystals; in which case a mixed kind of nucleus will be formed.

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* Lithic acid is well known to be capable of existing in a sort of semi-fluid state, or as a *hydrate*, for some time before it undergoes the process of crystallization. This may be illustrated by dissolving a little of this principle in an alkaline solution, and precipitating it, when cold, by the addition of muriatic acid. The lithic acid separates in the form of a bulky gelatinous mass, which after a greater or less time begins to diminish rapidly in magnitude, and at the same time to assume the crystallized form. The lithate of ammonia voided by birds, serpents, &c. and the lithate of soda formed in the human subject during gout, when first secreted, exist in this semi-fluid or plastic state, and afterwards become hard, apparently by undergoing an imperfect

I have hazarded the above explanation of the origin of lithic renal calculi, because it appears to me to throw considerable light on their formation

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kind of crystallization, by which they are separated from the water with which they are combined and held in imperfect solution. I have repeatedly seen both the lithic acid and lithate of ammonia deposited in the urine in this state of hydrate under the form of a gelatinous mass, having much the appearance of mucus, for which I at first mistook it.

and general history. It was suggested partly by a careful consideration of the symptoms attending their formation, and partly by the phenomena they present on dissection; both of which have been already detailed.

I have had fewer opportunities of examining renal calculi composed of the oxalate of lime, from their being comparatively more rare. Sometimes they are formed on a primary nucleus of lithic acid. In one or two instances I have seen them contain in their centre an irregular cavity, formed apparently by the agglutination of several imperfectly globular-shaped plastic masses round a substance which had subsequently been entirely removed or had disappeared by drying; the whole being afterwards surrounded by concentric laminæ of the same substance. It may, perhaps, appear difficult to conceive how a substance so insoluble as oxalate of lime can exist in a plastic state, or form a calculus at all; since, in our hands, this salt occurs only in the state of a powder, and seems incapable of concreting or assuming the crystallized form. Perhaps the circumstance may admit of an explanation, by supposing that a solution of oxalic acid nearly in a saturated state, and in union with a little lime, is secreted by a portion of one of the kidneys instead of the lithic acid in the former case; that this, enveloped in the usual animal matters, passes from the infundibulum into the pelvis of the kidney, and there meeting with the lime naturally contained in the urine secreted by the other parts of the kidney, instantly combines with it, and forms the compound in question; and that from the peculiar manner in which it is formed, and the abundance of animal matters present, it may be able to exist for some time at the temperature of the human body, in a plastic semi-fluid state, before the whole concretes into a solid mass. Whether this supposition be admitted or not, which is a matter of no importance, the facts are certain, that oxalate of lime not only does sometimes exist as an amorphous mass in renal calculi, but occasionally in the form of crystals also—a circumstance still more difficult to explain, except on some such supposition as the above.

Calculi of cystic oxide are extremely rare. From what has been already quoted on this subject, there is reason to conclude that they generally originate in the kidneys. I have only had an opportunity of examining two specimens of this species of calculi, with reference to their primary nuclei; in one of these the nucleus consisted of a small triangular amorphous mass, apparently of the same matter as the rest of the calculus, though a little deeper coloured. In the other no distinct nucleus could be discovered. From the peculiar nature of this species of calculus, there is, perhaps, little difficulty in supposing that it can readily exist and be secreted in a plastic state.

Nephritic calculi composed of the phosphates certainly exist; though they are very rare. This probably depends upon various circumstances.—In the first place, this form of the disease is seldom original, but consequent to others; and the system appears to be affected *generally*, rather than the kidney locally, as in the other forms of the disease. In the second place, the large flow of urine, and the consequent hurried state of action to which the kidneys are necessarily subject, may be justly considered as unfavourable to the formation of renal calculi. In some instances, however, as before stated, calculi composed of the phosphates are actually formed in the kidney; but in every instance of this description, the particulars of which I can trace, it has occurred only in very severe and obstinate cases of the phosphatic diathesis.

2. *Nephritis*, or *Inflammation of the kidney.*—Idiopathic inflammation of the kidney, compared with that accompanied by, or terminating in, the formation of renal calculus, is comparatively a rare form of disease. Like other internal inflammations, it commences by fever, which is sometimes of a highly phlogistic character, sometimes only moderate, but in all instances is accompanied by a decided hardness of pulse. There is acute burning pain in the region of one or both kidneys, accompanied by thirst, anxiety, restlessness, colicky pains, with constipation of the bowels for the most part, and sickness and vomiting. The urine, which at first is of a deep red colour, becomes limpid and colourless; and in the height of the disease there is a frequent desire to pass it off, but with very little effect, and

sometimes there is a total suppression when both kidneys are affected.

Inflammation of the kidney may be confined to its external membranes, or it may commence in its interior, and extend not only throughout its substance, but also to the neighbouring parts, in which cases the symptoms somewhat vary. When of an idiopathic character it is said that the pain of nephritis is less acute than when the inflammation has been induced by calculus, and that the uneasiness does not extend in so marked a manner, along the course of the ureter towards the groin, nor is so liable to be accompanied by painful retraction of the testicles, or numbness in the thighs, &c. There is likewise but little increase of pain produced on moving the body in nephritic attacks, by which they may be sufficiently distinguished from rheumatism.

Inflammation of the kidney may be produced by all those causes producing inflammation in general. Thus it has been known to come on after a fall producing some injury of the back. Sometimes it has followed long continued and violent horse exercise, particularly in hot weather; and occasionally it has been produced by the use of violent diuretics, as the oil of turpentine, cantharides, &c. Gouty and rheumatic individuals seem most subject to nephritis, and in them it is very liable to be induced by any exposure to cold, such as the sitting on a damp or cold seat, &c. Hence these affections appear to constitute the link as it were by which inflammation of the kidney is connected with calculus in that organ, this latter affection being apparently produced by the metastasis of gout and rheumatism to the kidney, more frequently than by any other cause. It may, however, be remarked, that whenever inflammation of any kind has existed in the kidney, or its neighbourhood, that organ is exceedingly apt to be left in a state of irritation, bordering perhaps on chronic inflammation; in which it seems particularly disposed to secrete lithic or oxalic acid: and hence, more especially after the age of forty, the formation of a calculus, sooner or later, is almost always the result of every inflammatory attack about the region of the kidney, whether that organ has been actually involved in it or not.

Inflammation of the kidney, in favourable cases, naturally terminates in resolution, &c. but it is also liable to be followed by all the usual consequences of inflammation in other parts of the body, such as *suppuration and abscess, indurated obliteration of structure, gangrene*, &c.

3. *Suppuration and abscess of the kidney.*—The usual termination of idiopathic inflammation of the kidney, as before observed, is resolution, or sometimes a discharge of blood, &c. When, in spite of all the means employed, it ends in suppuration or abscess, this event is indicated by rigors followed by exacerbations of fever and sweatings—in short, by all the usual symptoms of hectic. The urine at the same time becomes loaded with pus, or purulent-looking mucus, which frequently produces by its acrimony

much irritation in the bladder and urethra. In other instances the urine remains for some time clear, and the patient complains of a dull pain with a sense of fulness and weight in the loins. In this case the presence of an abscess in the substance of the organ may be suspected, which, after a greater or less interval, commonly bursts suddenly into the cavity of the kidney, when a large quantity of pus, blood, &c. is discharged, with the urine, with much irritation to the patient.

As before stated, suppuration and abscess of the kidney are almost always associated with, if not produced by, the irritation excited by calculi, and in such cases the calculi generally go on increasing, sometimes to an enormous size, while the kidney becomes more and more disorganized. In those instances, where the calculi block up the ureter, which sometimes happens, there is little pus discharged with the urine, but the patient continues to suffer, sometimes for many years, a variety of distressing symptoms, generally referred more or less to the seat of the disease. In some such cases the abscess has been known to point outwardly to the loins or back, where its contents have been discharged, and the patient, after much protracted misery, has either sunk under the affection, or in others experienced a partial recovery. In a few instances it has been known to burst into the abdominal cavity, and prove quickly fatal, &c. In the majority of cases the ureter remains more or less pervious, and the patient continues at intervals to discharge pus, and sometimes small calculi, blood, &c. with the urine, for a very long time. Generally one kidney only is affected, especially in the earlier stages of the affection, and the complaint may proceed till this be totally disorganized; but in old and protracted cases both kidneys frequently participate more or less in the affection.

Suppuration and abscess, apparently of a scrofulous character, have been described by authors, and I think, I have seen a few such instances. These may or may not be associated with calculus; but in those instances that have come to my knowledge, in which examination has been made after death, no calculus has been met with, but the whole substance of the kidneys has been nearly destroyed, and occupied by abscesses filled with much fœtid purulent matter. The symptoms of this species of abscess are often exceedingly obscure, especially in the latter and chronic stages of the complaint; and the pain, as Mr. Howship observes, is almost always referred, at this period of the disease, not to the kidney, but to the neck of the bladder. I have said, the latter period of the affection, for I have seen one case in which, from the constitution of the patient, the nature of the pus discharged and other circumstances, there could be little doubt of the scrofulous nature of the affection, but which had only *recently* appeared; the pain was wholly referred to the region of the kidney and ureter, as in ordinary cases.

In this case the *urine was acid, and, abstracting the pus, not very unnatural.* In the other cases I have seen, *the urine has been alkaline, and exceedingly fœtid and unnatural,* and in these the pain was referred chiefly *not to the kidney, but to the bladder.* Hence I have been led to infer, that the sufferings in the bladder are in part at least induced by the acrid nature of the urine, which is such that it could probably not be retained in a healthy bladder for a moment without producing the greatest agony.* The cases of this scrofulous affection of the kidney, that I have seen, have also been attended with indolent tumour and abscess of the inguinal glands, and by occasional pain and swelling in the testicles. They were accompanied by great extenuation of the body, and derangement of the general health, and in all instances ultimately proved fatal.

4. *Induration of the kidney.*—Another consequence of inflammation of the kidney, mentioned by different authors, is induration, sometimes of a scirrhus character, in which more or less of its natural structure is obliterated. Such appearances have been met with after death, but the characteristic symptoms attending them are unknown.

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* Mr. Howship, however, mentions instances of this form of disease, where the urine appeared *natural,* in which the pain was nevertheless chiefly referred to the bladder. Of course, in these cases, the properties of the urine could have nothing to do in exciting pain. On the complaints affecting the secretion and excretion of the urine, p. 24.

5. Violent inflammation of the kidney has also been known to end in *gangrene* in some very rare instances. This unfortunate event is indicated by the usual symptoms of the same termination in other parts of the body. The pain ceases more or less suddenly, the pulse sinks, and the fatal termination of the disease is speedy and inevitable.

6. Besides these affections of the kidney, which are the usual consequences of inflammation, a variety of other chronic diseases of that organ have been noticed by different authors, the peculiar symptoms attending which are so obscure, for the most part, that their exact nature can hardly be ascertained during the life-time of the patient; such are different affections of a supposed malignant character, as fungus hæmatodes, cancer, &c. Occasionally also these organs are met with after death in a state of preter-natural softness, or are found to contain hydatids or worms; the two last of which affections are sometimes rendered evident during life by the discharge of these animals with the urine.*

With respect to the *prognosis* in affections of the kidney, this of course will vary with the nature of the complaint. Generally speaking, it is not so unfavourable as might be expected; not that many of the diseases to which this organ is liable can be cured, but probably, as Dr. Baillie has observed, that very extensive disorganization of this organ does not interfere with its functions so much as might be expected, and "that a very small portion of the natural structure of the kidney is capable of secreting very nearly the ordinary quantity of urine." Frequently also only one kidney is affected, and in this case the other soon apparently becomes capable by its increased action of performing the office of both. Whatever may be the cause, it is certain, that individuals exist for a great number of years with extensive disease (especially those connected with calculous affections in the kidney) without being remarkable sufferers, and sometimes die at last from other diseases.*

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* See Baillie's Morbid Anatomy. Chopart Traité des Maladies des voies urinaires, &c.

Treatment. In active inflammation of the kidney in young and vigorous subjects, copious, and sometimes repeated abstractions of blood, both from the arm, and locally by cupping or leeches, are necessary; but in milder cases, and in old and debilitated subjects, the former is seldom required, at least to any great extent. These should be immediately followed up by the use of the hot bath, or hot fomentations over the region of the kidneys. Internally, at the same time, active doses of calomel may be exhibited, either alone or conjoined with opium or hyoscyamus, according to circumstances, and these may be followed, if the stomach will tolerate their use, by other purgatives, directed more or less to the kidneys, according to the judgment of the practitioner. When the inflammation is of a gouty character the colchicum is sometimes particularly beneficial, and in such instances warm mustard cataplasms may be applied to the feet. Some object to the use of blisters in this disease, and in the earlier stages they are useless, at least, and may do harm, but when the disease has begun to yield under the more active treatment above recommended, their application in general seems not only to be safe, but beneficial. Large emollient clysters also, with or without opium, according to circumstances, are sometimes particularly useful in the decline, and less active stages of nephritic attacks. Throughout the affection the strictest antiphlogistic regimen is to be adopted, and when the functions of the kidneys begin to return, warm emollient drinks, such as linseed tea, barley, or gum water, &c. may be taken plentifully and with advantage.

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* Cases are recorded in which calculi in the kidney have apparently proved fatal, by inducing irremediable inflammation of the stomach; and one such instance has come to my knowledge.

When the inflammation of the kidneys is supposed to be connected with the presence of renal calculi, which is by far the most frequent occurrence, means very similar to the above-named are to be had recourse to, with the view of removing it as soon as possible. In connexion with general blood-letting, or cupping (if necessary), and the warm bath, calomel, in active doses, when the constitution is otherwise sound, may be employed with great advantage, especially if it be immediately followed, or accompanied, by the use of hyoscyamus in pretty large doses, so as to ensure the antispasmodic effects of the latter on the system; and when the urine is high coloured and acid, the purgative effects of the calomel may be increased or kept up by the use of some of the diuretic purgatives, such as the neutral salts, and particularly the tartarized soda. This plan may be pursued for a greater or less time, according to the circumstances of the patient; and will, in favourable cases, be followed by the expulsion of the calculus from the kidney, without those very severe symptoms above described as commonly accompanying its descent down the ureter.

When, in spite of all these remedies, the calculus still remains in the kidney or ureter, or when, from the length of time the disease has existed, or from other circumstances, its expulsion appears hopeless, and the affection has assumed a chronic form, recourse can be only had to preventives and palliatives. Thus, if in the kidney, we may still hope to prevent its future enlargement, by a careful attention to all those circumstances formerly pointed out, as having a tendency to increase the deposition of the different varieties of calculous matter; the introduction of a seton or issue also, near the part affected, may be recommended; the good effects of which, as pointed out by Mr. Earle, cannot be disputed.* In such cases the urine may pass, in part at least, as usual; but those cases appear most hopeless, where the calculus has lodged in the ureter, and where the passage of the urine is completely stopped, and disorganization of the kidney has taken place in consequence. In such cases we can scarcely hope for advantage from any plan of treatment.

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* Med. Chirurg. Trans. xi. p. 211.

In cases of chronic suppuration and abscess of the kidney, where inflammation is absent, and the nature of the disease is evident by the purulent condition of the urine, &c. to alleviate the pain, anodynes, either internally or in the form of suppository or clyster, may be had recourse to. With these may be combined the *uva ursi,* either in the form of infusion or extract; the *pulvis tragacanthæ comp.* &c. Some have recommended the use of balsamic remedies, as *copaiba,* &c. in these affections; but I am afraid that in many instances the good effects of these as well as of all stimulating and diuretic remedies, are exceedingly doubtful.

In chronic affections of the kidney it is always absolutely necessary to attend to the state of the urine, otherwise a great deal of mischief may be done. This part of the subject will be more fully entered upon in the next section, though it may not be amiss to observe in general terms here, that if the urine be *acid,* in conjunction with the above remedies, small doses of alkali, as the carbonate of soda, may be exhibited with advantage; if *alkaline,* on the other hand, the judicious exhibition of acids may be useful. I do not think, however, that it will be prudent or safe, in any instance, to push alkaline remedies so far as to sensibly affect the urine for a considerable length of time together, least, in attempting to cure one disease, we produce a worse; hence the use of neutral salts containing a vegetable acid can seldom be required, and should in general be avoided.

The diet should be light and easy of digestion, and free from all stimulating condiments. In some instances a milk diet has been found particularly beneficial. Hard waters should likewise be shunned, as they frequently increase the pain and uneasiness in the back.

When the affection of the kidney is supposed to be of a scrofulous character, the same general principles are to be attended to, but, in conjunction with these, the tonic and restorative plan usually adopted in that disease may be employed, as far as circumstances will admit. In particular, warm sea-bathing may be sometimes resorted to with considerable advantage.

With respect to the other diseases of the kidney before-mentioned, such as cancer, hydatids, &c. even if the evidence of their existence be quite satisfactory, which is very seldom the case, no specific plan of treatment can be recommended; but the general principles above-mentioned being borne in mind by the practitioner, the palliatives, and other means, must be so exhibited, according to circumstances, as to diminish as much as possible the sufferings of the patient, and thus to preserve the general health unimpaired.

SECT. II.—*Calculous and other Affections of the Bladder and Prostate.*

A VERY large proportion of the organic affections of the bladder and prostate gland falls within the province of the surgeon; with his duties it is not my intention to interfere, but shall content myself with relating in as concise a manner as possible the leading symptoms of some of the most common diseases of these organs, chiefly with a view, in the first place, to the diagnosis between them and calculous affections; and, secondly, to the general principles, founded chiefly on the properties of the urine, by which the exhibition of remedies is to be regulated.

The most frequent origin of vesical calculi, as before stated, is the retention of a renal calculus in the bladder, where it constitutes a nucleus, round which the further accretion of calculous matter takes place. Sometimes, though much more rarely, this nucleus consists of a clot of blood, or hardened mucus; sometimes of a foreign substance introduced into the bladder, &c.

As to the future increase of vesical calculi, this, like their origin, is well understood: it being sufficiently obvious, that it can arise only from the gradual precipitation of that excess of the insoluble principles of the urine which cannot be retained in solution in that fluid. There are, however, some trifling varieties in the modes in which this precipitation takes place in the different species of calculus, which will be mentioned after we have considered the general nature of the supersaturated state of the urine alluded to.

Saturation in a saline solution of a constant temperature may be defined to be the point at which the solvent, always in contact with the salt, can neither take up any more, nor let go any more. Hence, every saline solution which precipitates a salt without any change of temperature, obviously contains more of that salt than is necessary to saturate it, or, such a solution is said to be supersaturated.

The point of *supersaturation* is unfixed, and depends upon many extraneous causes; but the point of *saturation*, although it for the most part varies with the temperature, is supposed to be as fixed and constant, at any given temperature, as that of the freezing or boiling of water. Hence, in a supersaturated solution, the excess is always sooner or later deposited, and the solution arrives at the point of *saturation.**

Let us apply these remarks to the subject in question. A calculus in the bladder may be considered as a substance placed in a solution of various principles in a certain quantity of water. If any of the more insoluble of these principles exist in this solution in a state of *supersaturation*, the calculus will afford a nucleus round which the *excess* will be deposited. But if none exist in a state of excess, of course none can be deposited, and the calculus will not increase in bulk.

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* See M. Gay Lussac, Ann. de Chimie et de Physique, xi. 296; Annals of Philosophy, xv. 1.

Such is the general nature of the increase of urinary calculi in the bladder; but a great deal of additional light is thrown on this subject, by a careful attention to the structure of urinary calculi. Thus, some of them have a crystallised texture, indicating purity; others exhibit an amorphous or earthy fracture, indicating for the most part impurity or mixture: while the general structure of almost all of them is laminated, indicating, as we shall attempt to show, that their formation has been interrupted, or has taken place at distant intervals. This is particularly the case with calculi composed of lithic acid, which constitutes the most frequent species.

The following are some of the reasons which appear to me to show, that calculi are formed at distant periods, and that their laminated structure can only be explained on this supposition.

There are innumerable cases on record, where calculi have been known to exist in the bladder for a great number of years, without attaining any very extraordinary magnitude. That such calculi were *constantly* increasing for such a length of time, is very difficult to conceive, for obvious reasons; and the difficulty is much increased when we take into account the well-known fact, that the urine of the same person differs exceedingly in its degree of saline impregnation at different times. Further, if a calculus was constantly increasing, its texture should be homogeneous. But they are *laminated;* and this laminated structure, while it is thus in direct opposition to the opinion of their being constantly on the increase, is just what might be expected to take place on the opposite supposition, that they are formed at different periods, separated by longer or shorter intervals. Thus, during these intervals of interruption in the formation of a calculus, its surface may be naturally supposed to become *water-worn,* and less apt for future accretion. Hence, when a tendency to deposition returns, it will have to commence *de novo,* and as it were upon the surface of a foreign body; the consequence will be, that the adhesion between the old and the new coats will be less firm than in the intermediate parts, and that a calculus, thus formed, will be disposed, when broken, to separate into concentric laminæ.

The usual symptoms attending the presence and future enlargement of a stone in the bladder have been so faithfully and distinctly narrated by Mr. Wilson, that I cannot do better than quote them here. In the early stages of the affection, and when the stone is small, "the patient," says Mr. Wilson, "on changing his position, or on making any hasty bodily exertion, feels a peculiar sensation at the end of the penis, as if suddenly called on to evacuate the urine, although the bladder may have been emptied immediately before; this sensation occasions the sufferer often to apply his hand to the part where it is felt; in children, when affected with stone, such action is constantly occurring. The sensation gradually changes to absolute pain, becoming progressively more constant and more severe. The desire to pass urine becomes more and more frequent, and as the irritability of the bladder increases so do the frequency and urgency of this desire; the urine, therefore, is discharged in very small quantities at a time, sometimes only drop by drop; occasionally a little blood accompanies the efforts to discharge it, and these efforts often bring on a painful tenesmus, and an irresistible desire to expel the contents of the rectum. In other instances, the patient is for a time free from pain, and a tolerably large quantity of urine is allowed to collect in the cavity of the bladder, which on evacuation will flow at first in a full stream, and without pain, when suddenly the stream shall at once stop, although much urine remains in the bladder, and the desire of passing it still continues urgent; this desire is consequently increased by the stoppage, and becomes most distressingly painful, and in proportion to the efforts made to pass the urine by pressure, the difficulty is increased, and the pain aggravated. On these occasions the change of position will do more than muscular efforts; for the stoppage being occasioned by the calculus gravitating to the orifice of the urethra, as the most depending part in the erect position, when the patient changes that position for the horizontal, and lies on his back, it then leaves the urethra open by falling to the part now become most depending, viz. between the ureters. So long as the urine continues to flow in a copious stream, usually little or no pain is felt, the urine defending the neck of the bladder from the stone; but when only a few drops of urine remain, the concreted mass and irritable membrane then coming in contact, much pain is excited. The urine deposits a large proportion of a mucous sediment, which is produced by the vessels and glands near the cervix of the bladder, being by the presence of the calculus excited to an increased secretion. Small portions of calculous matter occasionally come away with the urine, which, on these occasions, is generally, though not always, mixed with a ropy fluid tinged with blood; but some calculi are so firm and hard that this symptom does not take place.

" When the calculus obtains a large size, a dull but constant pain is felt at the neck of the bladder, and numbness and pain are sometimes perceived in the testicle and inner part of the thigh, extending downwards even to the bottom of the foot in some instances; * a painful sensation of weariness is also

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* I mentioned in the first edition of this work, that in severe cases of stone I had often witnessed a painful or uneasy sensation experienced by patients at the bottom of the foot, sometimes amounting to pain, at other times a sensation of numbness or itching. Mr. W. informs us, that he has seen the same,

felt in the back, which is increased by exercise, as indeed are all the symptoms, for the most part; more especially by riding on horseback, or in a carriage. The symptoms seem to be aggravated likewise when the stone presses upon the surface between the urethra and the ureters; and while in that situation very violent fits of pain occur, which are only relieved by the removal of the stone to some other part: various positions of the body are tried by the patient to effect this removal, even those where the fundus of the bladder is made the most dependent part. In the case of the enormous calculus, which has been published by Sir James Earle, the patient to evacuate his urine was obliged to place his body nearly in a vertical position, and to repeat this sometimes every ten minutes." *

These symptoms go on increasing for a period more or less considerable; when at length the patient's health gives way, and the diathesis, whatever it might have been before, changes to the phosphatic, and the coats of the bladder becoming diseased and thickened, the more distressing symptoms are aggravated in a tenfold degree, and death at last closes the scene of misery.

In some instances the calculi become enveloped in folds or cysts formed of the coats of the bladder: in

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not only in stone, but also in affections of the prostate; and I find that the circumstance has been noticed (though never publicly to my knowledge) by other surgeons.

* Lectures on the Urinary Organs, p. 226.

this case they often produce little inconvenience, and the symptoms, if any, are always more or less obscure, and hardly sufficiently characteristic enough to enable us to distinguish the nature of the affection from other chronic diseases of the bladder to be presently noticed.

Having thus detailed the symptoms produced by calculi in general, when lodged in the bladder, we come now to consider each particular species; and first,

Of Lithic Acid Calculi. When the general health is good, and the bladder free from disease, calculi composed of lithic acid, even when not encysted but quite loose in that organ, provided they are of small or ordinary size, and with a smooth surface, frequently give very little uneasiness; indeed many instances are on record where such calculi have been found in the bladder after death, the existence of which was never suspected during the life of the individual. Such instances, I presume, must be familiar to every one much conversant in the subject; and I shall only remark, that I knew a gentleman who was ascertained by sounding, seven years ago, to have stone in the bladder (evidently, from the history of the case, of the lithic species), but who for five or six years suffered so little from it, as for weeks together to be almost unconscious of its existence. This gentleman, when I first saw him, experienced a good deal of irritation, and the urine was very unnatural; but by means of the necessary remedies, and attention to diet, &c. the urine after a time became natural, and (as has for the most happened in similar instances) the irritation ceased in consequence. In further illustration of this fact also I may state, that I knew another instance where no less than four renal calculi of this species unquestionably existed in the bladder for five months, without producing any symptom whatever, except towards the end of the period a little irritation about the neck of the bladder, which caused their existence to be suspected, and led to the adoption of the necessary means for their expulsion. One of them was nearly an inch in length.

The urine, in this form of calculus, is always of the natural colour, more or less deep. Its specific gravity is higher than that of health; and it almost always deposits crystallized sediments on cooling, which are commonly much increased at certain periods, when the pain and irritation are worse than common; at these times also the crystallized sediments are not unfrequently accompanied by amorphous sediments, and much mucus. When, however, the stone is of small or ordinary size, the mucus is generally by no means so abundant in this species of calculus as in some others; and the urine, which is sometimes a little turbid at first, commonly becomes, after standing some time, perfectly transparent.

Oxalate of Lime and Cystic Oxide Calculi. We have seen in a former chapter, that the formation of the mulberry calculus is frequently associated with apparent health, and hence, when the bladder is free from disease, it has been remarked, that notwithstanding the roughness of its surface, this stone, when of small or ordinary size, excites much less irritation than might be expected.* When, however, of considerable size, the reverse is generally the case, and this stone is remarkable for producing very great suffering. The urine in this form of calculus (abstracting the mucus and blood with which it is frequently more or less mixed) apparently differs little from healthy urine; that is to say, it *is acid*, and *free from all gravelly deposites*, except, perhaps, occasionally a little lithate of ammonia; and it is from these two circumstances taken together, that we may be induced to suspect the presence of this form of stone; the symptoms attending which are, for the most part, of a more obscure character than those attending any other form of calculous affection.

I have never seen an instance in which a cystic oxide calculus existed in the bladder; but those subject to it are said to pass occasionally small fragments of that peculiar substance. I presume, also, that the properties of the urine must be always so characteristic in this form of disease, as in every instance to demonstrate unequivocally the nature of the calculus present.†

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* Wilson's Lectures on the Urinary Organs, p. 235.

† See page 165 of this volume.

Calculi composed of the Phosphates. Calculi composed entirely of the phosphates are, as we have formerly stated, of rare occurrence; but instances in which other diatheses have terminated in this deposition are very common. In either case, however, original or acquired, the agony produced by this species of calculus, when of considerable magnitude, far surpasses any thing I have ever witnessed from any other species. Not only are the local symptoms severe beyond measure, but the whole constitution seems to suffer in a striking manner; so that those who have been accustomed to see much of these complaints can almost tell even from the *looks* of a patient, that he is labouring under this form of the disease. An idea of the constitutional symptoms may be acquired from what has been before stated, when the different diatheses were treated of; and if we suppose the symptoms there detailed to be aggravated in a tenfold degree by all the local agonies of stone in its worst form, we shall obtain a faint idea of the sufferings of those poor wretches who are doomed to this species of calculus.

The urine in this form of the disease is so characteristic, that it cannot be mistaken for a moment. It is generally voided in considerable quantity, and is of a pale whey colour, and slightly opake. Its specific gravity is low, and usually varies between 1·006 and 1·012. It commonly deposits the phosphates in abundance, intermixed with a large quantity of a peculiar mucus, having a very characteristic appearance, but which is not easily described. It soon becomes alkaline, and undergoes the putrefactive process: and in this state emits a most offensive smell; and these changes take place so rapidly, that in severe cases it is difficult to keep a room sweet where a patient is confined with this affection. In short, the circumstances connected with this form of calculus are all so striking, that in the great majority of cases they must, I think, be sufficiently obvious even to the most superficial observers.

Calculi, or Concretions of the Prostate Gland. The concretions met with in the prostate gland, as formerly mentioned, consist essentially of the phosphate of lime and animal matter, and in a few instances the latter is present in considerable abundance, so as to even retain the original shape of the concretion, after the earthy matter has been removed by an acid.* The quantity of earthy matter sometimes secreted by this gland is almost incredible. Thus Mr. Wilson informs us, that he was in the habit of seeing a patient who, in the course of 15 years, voided as much at different times as would constitute four times the bulk of the whole gland.† These concretions when originally formed in the ducts or cells of the gland are of small size, and generally so imbedded in its substance as not to be in contact with each other, but as they acquire magnitude, ulceration or absorption takes place, by which means several of the cavities are brought into communication with one another. Hence, not unfrequently, a large number (amounting to 50 or 60, for example) of these concretions, varying in size from that of a small pin's head to hazle nuts, are met with in the same cyst or abscess. In some rare instances, however, the earthy matter collects itself into comparatively a few masses only, in which case they acquire a much larger magnitude. There is a remarkable specimen of this kind in the Museum of the Royal College of Surgeons, in which, with the exception of a few fragments, the whole of the earthy matter is collected into four masses, which together weigh no less than 575 grs.; and the largest mass alone weighs 395 grs. In such instances these concretions have been very naturally mistaken for urinary calculi,* which indeed they often resemble, not only in their appearance, but their composition; for when the urine has access to the cavity of the cyst or abscess in which they are formed, they sometimes contain more or less of the triple phosphate of magnesia and ammonia, derived from that source. This circumstance existed in the case from which the specimen in the Museum of the Royal College of Surgeons above-mentioned was taken; and hence, though the great bulk of these calculi are unquestionably, I think, of prostatal origin; yet their appearance, as well as probably their composition, are considerably modified by an admixture of the triple phosphate.

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* I have recently found a considerable proportion of carbonate of lime in a small prostatal calculus.

† Lectures on the Urinary Organs, p. 354.

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* Is not the large calculus, depicted by Dr. Baillie (plate iii. fasciculus 7), and stated to consist of phosphate of lime, of prostatal origin, and hence referrible to the class of concretions we are considering?

With respect to the origin and nature of prostatal concretions, I have been always disposed to consider them as precisely analogous to those morbid ossifications or concretions which are occasionally found in other parts of the body, as the lungs, &c. These concretions frequently contain the carbonate of lime; and the circumstance of this substance having been also found in a prostatal calculus, seems to render the above opinion still further probable.

The symptoms produced by the presence of concretions in the prostate are often very obscure, and sometimes with difficulty distinguished from those accompanying other affections of that gland, or stone in the bladder. The symptoms of course will vary considerably according to the size, number, and situation of the calculi. "When small and not projecting they sometimes have produced so little uneasiness as not to have been suspected during life: they are generally, however, attended with some difficulty in voiding the urine, and a sensation of uneasiness about the neck of the bladder. This uneasiness is occasionally increased by violent exercise; but so it would be, did it proceed from stone in the bladder. When they project towards the urethra, or produce a difficulty of passing the water, and an instrument is introduced, either to search the passages, or the bladder of urine, they will in some instances be found to grate against it, giving that peculiar feel to the surgeon which cannot be mistaken; but they may be pushed back by the instrument into the cavity of the prostate, so as not to be discoverable in several subsequent examinations." * Should the least fragment of the calculus escape, a chemical examination of its properties will at once set the nature of the affection at rest.

When a number of these calculi have been lodged in a cyst in the prostate they have been known to produce retention of urine, and various other distressing symptoms. Such a case is related by Mr. Brodie, † where calculi were successfully removed, at ten or twelve operations, to the number of 60 and upwards, by Weiss's instrument. These calculi varied from the size of a pin's head to that of a pea, and many of them were much larger. The largest measured half an inch in one direction, and $\frac{3}{8}$ of an inch in the other, and had four sides and angles, and was with difficulty, and not till after three or four trials, removed. In the month of May last I saw this gentleman with Mr. Brodie. During the interval between the preceding operations and that time he had passed many calculi without the instrument, and at the period above-mentioned he had symptoms of the presence of others: from these,

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* Wilson's Lectures on the Urinary Organs, p. 355

† Med. Chirurg. Trans. xii. p. 382.

however, he suffered but little inconvenience; the general health also was good, and the urine, abstracting the fœtid alkaline mucus that was usually passed with it in greater or less quantity, was *acid*, and in other respects very little changed from the natural state. All the calculi removed from this gentleman that I saw seemed to be of the same nature, and were composed essentially of the phosphate of lime and animal matter, and hence were undoubtedly of prostatal origin.

With respect to the causes giving origin to the formation of concretions in the prostate gland, they are very obscure; but it has been remarked, that they most frequently occur in those who have suffered from other diseases of the urinary organs, and more especially in those in whom the urethra has been long diseased. As to the prognosis, this, upon the whole, can scarcely be considered unfavourable, more especially when they are of small size, as in this case they often produce little or no inconvenience; when large and numerous, and consequently connected with extensive disorganization of the gland, they become more formidable; and in all instances there is a possibility of their causing retention of urine, or of their getting into the bladder, and thus producing more or less of the symptoms and consequences of stone in that organ.

2. *Cystitis*, or *Inflammation of the Bladder*, &c. Acute inflammation of the bladder is attended by a severe burning and throbbing pain, with a sen-

sation of tightness and constriction in the hypogastric region. The pain, which is much increased by pressure, extends with more or less rapidity and intensity to the neighbouring organs, and the patient feels almost a constant desire to make water without being able to accomplish it; and if a little urine be passed, it is commonly found to be of a deep red colour, and of high specific gravity—sometimes semi-transparent, at other times depositing a sediment, and not unfrequently mixed with blood. The pulse is generally frequent, hard, and full—sometimes irregular, the skin hot and dry, and the thirst urgent. As the disease proceeds the pain seems to extend more to the other abdominal viscera, and the rectum is commonly particularly affected. There is also vast restlessness and anxiety, nausea, vomiting, tension of the abdomen, twitching of the tendons, &c. and the urine flows in drops involuntarily. To these succeed more or less of swellings in the loins, accompanied by rigors, coldness of the extremities, watchfulness, and delirium; and at length convulsions generally come on, in the midst of which the patient usually expires.

Such are the symptoms of this affection, as described by authors, when permitted to run its course; but it may be proper to mention, that in the earlier stages of the affection they vary somewhat, according to the seat of the inflammation. Most generally this occupies the lower part and neck of the bladder; in which case there is commonly more or less of retention of urine, and the pain produced on introducing the catheter, at the moment it enters the bladder, is severe beyond endurance. Sometimes, the inflammation occupies that part of the bladder, in which the mouths of the ureters are situated, which thus become involved in the affection, and a suppression of urine, more or less complete, and its consequences, take place; in this case there is commonly more or less of pain and tenderness on pressure in the hypogastric region. When the posterior portion of the bladder is affected, the rectum suffers more particularly, and the patient is harassed by a most distressing and constant tenesmus.

On examination of those who have died from inflammation of the bladder, it has been found, that not only the proper membranes of that organ have suffered severely from the disease, but frequently that the peritonæal covering has also participated, and that extensive cohesions with various parts, and particularly the rectum, have taken place.* The inferior portion of the bladder, and its neck, however, have been generally observed to suffer most. Sometimes the bladder has been found in a gangrenous state.

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* Mr. Wilson observes, "The inner membrane of the bladder has not, in the natural state, many vessels large enough to contain red blood; but when inflamed the trunks enlarge, and the minute vessels are then found to be sufficiently numerous to impart a florid red appearance to the whole surface. When the inflammation runs high the muscular coat may be affected, and sometimes the peritonæal also; but as the inner membrane is loosely attached to the muscular, the inflammation is often prevented from extending from the one to the other." Lectures on the Urinary Organs, p. 297.

Inflammation of the Prostate Gland, when commencing in, and confined to, that portion of the urinary canal, is indicated by a sense of extraordinary heat and weight in the seat of the part affected; to which soon succeeds a continued throbbing pain, which is much increased by pressure on the part, as by examination through the rectum, or when the patient goes to stool. Generally also after an evacuation of the bowels, however complete it may be, the sensation still remains of something being left behind. The passing of the urine also, of which, for the most part, there is a frequent and urgent desire, commonly excites much pain. Under these circumstances the pulse soon becomes affected, denoting more or less of fever, which, in many instances, assumes an *intermittent* character.

Such are the usual symptoms, when inflammation is chiefly confined to the prostate gland; but very generally in such cases the affection rapidly spreads to the neck of the bladder, and more or less to its inner surface, when the peculiar symptoms become blended with those of cystitis above related, and are with difficulty distinguished from them.

In gouty individuals, who have likewise suffered from urinary derangements, a severe affection ultimately involving the whole urinary system, and which, for want of a better name, must be termed *inflammatory*, though the circumstances attending it differ altogether from those of common inflammation, sometimes occurs. Hitherto I have only seen this affection take place after an irregular attack of gout. It commences with slight rigors, followed by feverish exacerbations, and accompanied by unusual prostration of strength, and mental depression. These symptoms of constitutional derangement soon assume a more violent character, the pulse becomes excessively quick, the skin hot and dry, the stomach oppressed with nausea and vomiting; there is tendency to delirium, and, in short, to all the symptoms of irritative fever of the most formidable kind. At this time the secretion and excretion of the urine are not apparently affected; and the patient, though repeatedly urged on the subject, declares he has no pain, either in the urinary system or elsewhere, nor does he complain when examination or pressure is made. These symptoms go on increasing in spite of every remedy, when at length the external organs sometimes become tumid, and retention of urine more or less complete is perceived for the first time. The powers of the patient now sink rapidly, the whole tumid urinary organs acquire a dull livid hue, and death speedily closes the melancholy scene.

In the two or three instances of this most dangerous affection that have fallen under my observation, its general symptoms and progress have been as above described, though some of the subordinate symptoms have varied according to the constitution and circumstances of the patient; and in one case in particular the evidence of the affection of the urinary system was more unequivocal from the beginning, though it was not attended, even in the latter stages, by any very remarkable tumid state or lividity of the external organs. With respect to the nature of this affection, some may, perhaps, think it of a gouty character. Whatever may be its nature, the inflammatory action seems, if it be not originally of that character, to very speedily assume the *atonic* form; and were I required to point out its analogies, I should say, that it more closely resembles that most dangerous form of inflammation termed *diffusive* or *erisipelatous*, than any thing else that I am acquainted with. I can give no account of the appearances after death in this affection, though from what I have seen I can scarcely conceive recovery from it possible.

The exciting causes of inflammation of the bladder may be various; such as the presence of calculi, some external injury, as a blow, &c. over the region of the bladder, violent or long continued horse or carriage exercise, too long a retention of the urine, exposure to cold, as by sitting on a cold or damp seat, repelled gonorrhœa, &c. The most common causes producing this affection, particularly in advanced life, when there is supposed to be an increased disposition to affections of the urinary organs in general, are, repelled gouty, or exanthematous affections, the sudden ceasing of accustomed discharges of blood, as hæmorrhois, &c.; the use of acrid diuretic remedies, as cantharides or turpentine, the habitual use of high seasoned dishes, with the excessive use of strong wines, ardent spirits, &c. to which may be but too frequently added the abuse or mismanagement of instruments for strictures in the urethra, &c.

Acute inflammation of the bladder has always been considered as a very dangerous affection. Even in the young and healthy, if it does not prove fatal, it but too frequently leaves the most troublesome consequences; and in the old and debilitated, if they escape from its immediate effects, the consequences are generally such as to render them miserable for life afterwards. Nearly the same remarks are applicable to inflammation of the prostate; though authors mention a common phlegmonous inflammation, to which this gland in young persons is sometimes liable, that commonly terminates without any bad consequences, when properly treated at an early period of the attack.*

Besides acute inflammation of the bladder and prostate, these organs are subject to various chronic affections, supposed to be generally of an inflammatory nature, and which give origin to a variety of distressing symptoms. Many of these are of too indefinite a character to be described, though some of them will be briefly considered under the head of *irritable bladder*. There are, however, a few affections of the bladder of so characteristic a nature as to deserve a separate consideration in this place; of these, the first I shall notice is,

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* See Wilson's Lectures, p. 326.

8. *Cystirrhœa, or Catarrhus vesicæ.* This affection is supposed to be connected with a peculiar inflammatory action of the mucous membrane lining the bladder,* giving rise to an inordinate secretion of the mucous fluid, which that membrane naturally secretes, and with which it is properly lubricated.

The first attack of this affection is sometimes sudden; at other times it is preceded by a feeling of oppression at the stomach, with spasm and extraordinary relaxation of the bowels. At the same time there is occasional lancinating pains, with burning heat and spasms in the region of the bladder, which are frequently accompanied by a sense of weight in the perinæum, and a tendency to hæmorrhois. With these symptoms, which denote a sudden increase of irritability in the whole urinary system, there is likewise, as the disease becomes more

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[*] This inflammatory action, however, if it be worthy of the name, must differ from common inflammation; for in one instance in which a small calculus was contained in the bladder, and in which a large quantity of mucus, resembling that passed in the present affection, had almost constantly for years been secreted by the inner coat of that organ, this entirely disappeared when acute inflammation of the common kind was excited in the bladder by the same calculus, owing to the patient's having imprudently taken a long journey in a rough carriage. Some, however, may probably think this circumstance easily explicable on certain physiological principles.

fully developed, a constant and urgent desire to pass urine, accompanied frequently with much spasm of the bladder and urethra, and the discharge more or less of an adhesive mucus. A slow fever generally accompanies the affection, and the patient complains of thirst, with a sense of general debility, particularly about the back and loins; and what between the constant irritation and want of rest, and the great drainage from the system, there is always in protracted cases a great falling off of the strength and flesh; and the patient, if not cut off by the organic destruction it occasions, which is the most frequent termination of the disease, dies at last quite exhausted.

The urine, in slight and incipient cases of this affection, when first past, generally appears of a whitish colour, and is more or less opake and turbid, with the appearance of flocculi floating through it. On standing, however, for some time, it becomes more or less transparent, and the mucus will be found together in a mass at the bottom of the vessel. In most cases at this period, the urine, abstracting the mucus, will be found to be *acid*, and in other respects not very unnatural; while, on the other hand, the mucus will be neutral at least, if not alkaline, in which state it continues throughout the disease. The mucus varies considerably in its appearances in different instances, and even in the same person at different times. Sometimes it is easily diffusible through the urine; at other times it is so tenacious that when it has been once suffered to cohere it cannot be again easily mixed with the urine, at least by simple agitation. As the disease proceeds, the quantity of mucus secreted is sometimes enormous, amounting to several pints in the day; and in this case it not only comes away diffused through the urine, but likewise in the form of large coagula, which by blocking up the urethra give origin to the most distressing symptoms, and particularly to a sense of severe burning pain along the whole course of the urethra, from their alkalescent properties. I have frequently remarked in this extreme form of the disease, that the mucus becomes much stiffer on cooling, apparently undergoing a species of coagulation, not much unlike that of the fibrin of the blood; in this case the mass of mucus assumes so tenacious a character, that it may be drawn into strings of considerable length, and the vessel may be frequently inverted without its falling out. The mucus has generally an opalescent appearance, or sometimes it is quite opake, but in the advanced stages of the complaint it frequently assumes a more purulent like character, and becomes of a yellowish or greenish colour, or is sometimes streaked with blood. The urine also, as the disease proceeds, generally loses its transparency, and becomes more or less serous and alkalescent.

This disease, as before observed, is generally complicated in its advanced stages, with ulceration of the bladder; and the prostate gland also, if not originally affected, for the most part, at this period, becomes more or less implicated in the consequences. In these severe forms of the disease the most distressing hæmorrhage from the bladder sometimes takes place; and even the kidneys become involved in the affection, as is evident from the unnatural state of the urine above-mentioned.

Catarrhus vesicæ, in its worst form at least, may in general, be considered as a disease of advanced age. In some countries, however, it is said to be very rare, while it abounds in others, and something like it has been even known to assume an epidemic character. Most frequently it attacks the gouty; and the worst case I ever witnessed occurred in a gentleman, who for many years had been a martyr to gout, and in whom it succeeded to an acute seizure in the bladder, that took place during an attack of that affection. There are some habits apparently more predisposed to this affection than, others, such are those of an irritable scrofulous temperament, with fair skin and tendency to cutaneous affections; more especially if they have been accustomed to live freely, or been given to venereal excesses, or have suffered from these affections or gout. In such individuals exposure to cold seems one of the most frequent exciting causes of this affection, and those who actually labour under it are generally found to suffer much more severely in cold weather. Other exciting causes mentioned by authors are acrid diuretics, long and excessive riding on horseback, hæmorrhois, the presence of worms in the intestinal canal, &c.

This affection is usually of a chronic character; and when it occurs in old people, and is complicated with disease of the bladder, &c. it but too frequently terminates with the life of the patient. In some cases of a milder character it has been observed to come on and terminate in a short time, or occasionally to assume an intermittent form, especially when associated with hæmorrhois, or certain affections of a petechial character. Those also who are subject to it have frequent relapses; and in all instances its complete cure may be considered as very difficult. Besides disorganization of the bladder, the usual consequence of protracted cystirrhœa, this affection sometimes terminates in paralysis of that organ; and in all instances the internal membrane becomes highly vascular, and occasionally puts on a varicose appearance.

4. *Ulceration, &c. of the Bladder and Prostate.* The presence of superficial ulceration of the bladder may be sometimes suspected from the preceding history of the case, and from the appearances of the urine, &c. but for the most part there are no symptoms attending this affection of so characteristic a nature, as to lead to a satisfactory knowledge of the extent, or even the seat of the affection. Pain and irritation in the bladder, with more or less of blood or pus in the urine, are always present, but so they are in many other affections of the urinary organs;

hence we learn little from these, and we are but too often compelled to remain in ignorance of the extent and seat of the mischief, till the coats of the bladder becoming penetrated, the urine suddenly makes its way in some direction or other according to the seat of the ulcer, and the life of the patient is thus placed in imminent danger. When the ulcer is situated in the inferior or back part of the bladder, the urine making its way through the cellular texture sometimes extends downwards to the perinæum and scrotum, there producing the most terrible inflammation, &c. Most generally, however, in this case it penetrates to the rectum, or sometimes in woman to the vagina. When the ulcer is situated in the anterior part of the bladder, the urine has been known to make its way into the cellular substance between the peritonæum, and abdominal muscles. At other times the ulcer has communicated with the cavity of the abdomen, and in this case the consequences are speedily fatal. In surgical authors who have treated of these affections, and to whom the consideration of them properly belongs, innumerable instances of these, and other severe consequences of ulceration in the bladder, &c. will be met with, to whom I refer the reader who wishes for more particular information on the subject.

Suppuration and Abscess of the Prostate Gland, or rather, according to Soemmering, of the cellular envelope of the gland, are sometimes in young subjects consequences of common phlegmonous inflammation. In such cases, after the pus is discharged (generally by the urethra), the disease terminates favourably, and without leaving any bad consequences. Sometimes in early and middle life these affections appear to be of a scrofulous character, in which case they are more formidable; but the most formidable of all are the extensive ulceration, and abscesses which take place in old people, and which are commonly accompanied by, or terminate in, complete disorganization of this organ, and sooner or later the death of the patient. These affections of the prostate gland are all accompanied by very distressing symptoms, besides those connected with the mechanical difficulty of emptying the bladder of its contents, and their management falls almost exclusively within the province of the surgeon. My object in mentioning them here is chiefly with the view of completing my plan, and more particularly of drawing the attention of the surgeon to the state of the urine in these different affections, from which a great deal, not only of diagnostic, but of practical information, may be sometimes drawn, as will, I trust, be sufficiently apparent from the principles which have been already explained, and which it is the general object of the present volume to establish.

Suppuration and ulceration of the bladder and prostate may, as before mentioned, be consequences of many of the diseases of that organ, already considered. Since the introduction, however, of the venereal disease into Europe, this has proved the most fertile source of organic affections of the urinary organs in general; and the diseases under consideration in particular may be more frequently traced, either directly or indirectly, to some one or other of the forms of this loathsome affection than to any other cause.

5. *Thickening of the Coats of the Bladder*, with *chronic Enlargement of the Prostate*, are diseases of these organs very frequently, though perhaps not necessarily, associated. In the first of these affections the coats of the bladder often acquire a thickness three or four times greater than natural, and sometimes little pouches are formed by the inner membrane, between the muscular fasciculi. This preternatural thickness has been supposed to depend, and evidently does so in some instances, upon an enlargement of the muscular fibres, produced apparently by the increased exertion required in many diseases of the bladder, and particularly of the prostate gland, to propel the urine. In other cases, this explanation can hardly, perhaps, be admitted; and the bladder in becoming thicker, becomes also hard and rigid, and seems, in short, to participate in the affection of the prostate. Sometimes the ureters become thick and enlarged, and seem to be involved in the disease, and in some instances it has been said even the kidneys themselves.

In cases of thickening of the coats of the bladder, particularly when of an extreme character, that [illegible] be felt at all times above the pubes. The patient also is conscious of a weight in the hypogastric region, and is sometimes troubled with incontinence of urine, and in all cases there is a frequent desire to make water, from the contracted cavity of the bladder, the rigid nature of which will not permit it to distend itself. The bladder also sometimes compresses the nerves and vessels in its neighbourhood, in a greater or less degree, thus giving origin to a variety of unpleasant sensations in the lower extremities, sometimes so troublesome that the patient cannot rest a moment quiet; at other times amounting to paralysis more or less complete. There is generally also more or less of difficulty in passing the fæces, owing to the pressure of the bladder on the rectum.

Chronic Enlargement of the Prostate Gland is a very common affection in old men. In this affection the gland, which in its healthy state is not larger than a walnut, becomes much enlarged in bulk and weight, and in some instances acquires an enormous magnitude. In this enlargement of the gland there is always more or less of difficulty in passing the water, more especially when the middle and posterior part of it, or what Sir E. Home calls the middle lobe, is chiefly affected, in which case the passage of the urine is not only apt to be completely stopped, but sometimes the difficulty in introducing an instrument is very great. Occasionally one side of the gland is affected more than the other, when the passage through it is rendered tortuous, and the difficulty still further increased. The prostate gland in this enlarged state, when cut into, generally exhibits a firm whitish or brown substance, with membranous septa running through it in various directions; in some instances it has been found of a cartilaginous or even bony texture. This affection of the prostate gland is not so prone to ulceration as similar affections in other parts of the body sometimes are. Occasionally, however, it inflames, thus giving origin to the usual symptoms in an aggravated form, and in this case the inflammation may extend to the bladder, &c., and there terminate in suppuration or ulcer. The most common consequence of this affection, is the thickening of the coats of the bladder above described. The symptoms of this condition of the gland have been already mentioned, and in general its presence can always be determined by examination through the rectum.

In some families this affection appears to be much more common than in others; and when the tendency to it is thus inherited, it sometimes makes its appearance much earlier in life; generally, however, it is a disease of advanced age, and it occurs particularly in those who have lived freely, and have suffered from gonorrhœa, or other affections of the urinary organs, or who have been all their lives accustomed to severe horse exercise, &c. It is said that scrofulous habits are more subject to it than others, and the swelling has been found of a scrofulous character. The left lobe is also said to be more frequently affected than the right.

The urine in the earlier stages of this affection is frequently very little deranged, and but little trouble is derived from this source; but in the advanced stages of the disease, as in most others, it commonly becomes more or less of an alkaline character, and deposits the phosphates. By this circumstance the sufferings of the patient are exceedingly aggravated; for as the urine is never completely evacuated without the use of an instrument, in addition to his other sufferings from the unnatural state of the urine, and its retention in the bladder, a stone is not unfrequently formed in that organ.

Besides these affections of the bladder and prostate, there are many others related by authors, connected with organic derangement of these organs, the symptoms attending which lead to no distinct knowledge of their nature during the life of the patient, and, even if known, to no peculiar plan of treatment. Such are *fungous excrescences* of the bladder; these are rare, and usually occupy the inferior and posterior parts of the bladder; sometimes they appear to be of a malignant character: they occur most generally in the bladders of old drunkards and libertines, and frequently appear to be remote consequences of syphilis, especially in scrofulous habits. *Polypous excrescences* have been met with in the bladder in some very rare instances; also *elongations of its inner membrane, cysts communicating with its cavity*, &c. for the particular circumstances attending all which I must refer to systematic and surgical authors, there being for the most part very little to be done in such affections, and that little usually of a surgical nature.

6. *Spasm and Paralysis of the Bladder.* Spasm of the bladder often accompanies the presence of a stone in that organ, as well as many other affections to which it is liable. It not unfrequently also accompanies diseases of the kidney, rectum, uterus, &c. and in some instances has been known to recur periodically. There is also an idiopathic spasm of the bladder, mentioned by some authors, and to which old men are said to be particularly liable, though the existence of this seems to be doubted altogether by others, who consider it as merely symptomatic of some other disease.

In the particular affection alluded to, as well as in other instances of spasmodic affection of this organ, the patient experiences an acute pain in the region of the bladder, accompanied by a sense of constriction. This pain often extends along the urethra, and gives occasion frequently to the most painful erections. There is more or less of retention of urine, and sometimes of suppression, on account of the urine being unable to enter the bladder; in this case the urine accumulates in the ureters, &c. which become distended and exceedingly painful, and the pain is propagated to the kidneys, loins, testicles, and even the thighs. The bladder is generally contracted, and resembles a hard ball, which pressing on the rectum produces a frequent desire, without the power of going to stool, and sometimes ends in protrusion of the rectum. These symptoms are accompanied by great uneasiness, agitation, and restlessness, with a cold clammy perspiration, extending more or less over the body; and in those unfortunate cases, in which it goes on in spite of remedies for some hours, the extremities become cold, the patient falls into a state of despair, or syncope, convulsions come on, and death very soon succeeds; or in some instances the patient dies with all the circumstances attending suppression of urine.

The symptoms attending spasmodic affections of the bladder often resemble those produced by other affections of that organ, and particularly inflammation. Hence attention should be paid to those diagnostic points by which they may be distinguished from one another; the chief of these are the following:—Cystitis is accompanied by all the symptoms of fever, while spasm is not. Pressure increases the pain of cystitis, but not of spasm. The pain is unceasing in inflammation, that of spasm comes on in paroxysms. The pain in cystitis is burning, throbbing, or lancinating; in spasm it is oppressive, dragging, and resembling labour pains. The constitution also of the patient should be taken into account; in the robust and sanguine, cystitis is the most probable disease; in the weak and nervous, spasm. These differences will direct to a knowledge of the disease in well marked cases; but in others, or when both affections coexist, which, is by far the most frequent occurrence they are of much less utility.

Besides stone in the bladder, spasm of that organ may arise from, or rather accompany various other affections, such as the presence of acrid urine or pus from an abscess in the kidney; from ulceration or other organic disease of the bladder itself; from retention of urine, from gout, from excessive venery, or the use of irritating diuretics, as cantharides; from various diseases of the intestinal canal, as worms, and especially ascarides, &c. Slighter cases in young subjects in general are not dangerous, and sometimes subside spontaneously. The affection is most dangerous in old people, and in proportion to its duration and intensity; and when it depends on a cause that cannot be removed, it is very apt to end in the affection next to be considered, namely,

Paralysis of the Bladder. Paralysis of the bladder is a state of that organ in all respects opposed to the last affection. For the most part it is a disease of old age, and is connected with the general loss of power that takes place at that period. In this affection there is a sense of uneasiness, and sometimes of severe pain in the neck of the bladder, showing that the sensibility of the organ is left, though its irritability be lost; this is accompanied by a feeling of oppressive weight and tension, with the inability of obtaining relief by passing off the urine; and sometimes the bladder, from habitual distention, acquires an enormous bulk; sooner or later, if relief be not obtained, the patient dies with all the symptoms of suppression of urine; or, in some instances, rupture of the bladder has taken place.

This affection is often complicated with others, from which it is sometimes difficult to distinguish it: the previous history of the patient, however, with the general absence of pain, the great distention of the bladder, &c. are commonly sufficient to lead to a knowledge or suspicion of the nature of the affection.

When the neck of the bladder is involved in the disease, the patient becomes incapable of retaining his urine, which flows from him involuntarily. See *Incontinence of Urine.*

The remote causes of paralysis of the bladder may be various. A tendency to it seems to be frequently induced by the abuse of venereal matters in early life, too free living, &c. The occasional causes may be too long a retention of urine, apoplexy and general paralysis, injuries of the spine, &c. also gouty attacks, and various other affections of the bladder.

We now come to the treatment of these affections, and first, of the

Treatment of Calculus in the Bladder. The arrival of the little renal calculus in the bladder, as related in the last chapter, constitutes a most important period in the history and treatment of calculous affections, for on the means then adopted its retention or expulsion will, in many instances, almost entirely depend. In favourable cases the calculus is immediately expelled from the bladder by the urethra, particularly if the proper means have been resorted to; but frequently it is retained for the present; and at length, after a greater or less interval, when the irritation of the parts has subsided a little, it usually comes away when it was least expected. These circumstances lead to a plan of treatment somewhat different from those commonly recommended, and which I have seen eminently successful.

This plan is similar in its principles to that above related for expelling the calculus from the kidney, and is moreover partly founded on the obvious assumption, that whatever can pass down the ureter will pass by the urethra, provided that canal be in its natural state. Hence, the principles of treatment are very simple, and consist in nothing more than in attempting to allay by antispasmodics, and particularly by hyoscyamus, that irritable state of the urinary organs, and especially of the sphincter vesicæ, which seems to exist under these circumstances, and to prevent the calculus from entering the urethra; and afterwards, or rather at the same time, to favour the expulsion of the calculus, by exhibiting diuretic purgatives, with the view of exciting an increased flow of urine. By this plan I have seen calculi removed from the bladder in a few hours, which had been apparently retained there for several months, and in one instance, beyond a doubt, as long as *five* months.

In those instances, where either from the magnitude of the stone, or peculiar irritability of the constitution, it does not come away, after a fair trial of the above treatment, recourse should be had to dilatation of the urethra by means of bougies, &c., and should these not succeed, an attempt should be made to extract it through the urethra, by means of Weiss's forceps, as first practised by Sir A. Cooper. This last plan, if resorted to in time, can hardly ever fail, at least in the adult state.

In those unfortunate instances where, from neglect or other circumstances, a stone exists in the bladder too large to be removed by the above means, the treatment to be adopted will be of a twofold character, viz. general and local. The *general* treatment will depend very much upon the nature of the prevalent diathesis, and the state of the urine; hence we shall consider the subject under these different points of view; and first of the

Lithic Acid Calculus. As far as I have hitherto remarked, the distressing symptoms produced by this species of calculus, as is indeed more or less true with all the others, have a very constant relation to the severity of the diathesis present. That is to say, in proportion as the urine is unnatural and loaded with gravel and amorphous sediments, in the same proportion are the patient's sufferings. Hence our first object should be to restore the urine to its natural state. To accomplish this, the means formerly recommended should be had recourse to, in conjunction, if necessary, with the local employment of anodynes in the way below mentioned. Perhaps, however, it may not be deemed superfluous if I briefly recapitulate these means. We shall suppose the diathesis distinctly present, that the urine is high coloured, of great specific gravity, and loaded with amorphous and crystallized sediments, &c. The first means to be recommended, in ordinary cases, is some alterative, as the Plummer's pill, to be taken at night, and followed up the next morning by an alkaline diuretic purgative, composed, for example, of a mixture of Rochelle salts and magnesia, or subcarbonate of soda: during the day a strong infusion of uva ursi, combined with hyoscyamus and the *liq. potassæ*, &c. may be taken. These means are to be persisted in for a greater or less time, according to the circumstances, and till the urine begins to get natural; it may then be gradually left off, or varied, as occasion may require; and under this plan it will be found that, in favourable cases, not only the urine will assume its natural state, but most, or all the distressing symptoms of calculus in the bladder, will be very much diminished, and in many instances disappear. It is obvious, also, that while the urine is in its natural state, the calculus cannot increase in size.

After the diathesis is once fairly broken by these means, it may in general be prevented from recurring by attention to diet, and other circumstances formerly mentioned as inducing this diathesis, and by the occasional use of medicines; and the patient will scarcely know that he has calculus in the bladder, at least from the pain that it gives him. I state this with confidence; but, at the same time, I wish to be understood to mean, that the freedom from pain, &c. depend in no inconsiderable degree upon the size of the calculus, its smoothness, upon the exercise a patient is obliged to take, &c. all of which are presumed to be favourable; for it must be sufficiently obvious that a foreign substance in the bladder cannot be prevented from acting *mechanically*, and from occasionally producing bloody urine, or a temporary stoppage of the discharge of that secretion from the bladder, and similar symptoms, especially if the patient be obliged to take severe exercise.

Lithate of Ammonia Calculus. If this calculus, from the state of the urine and symptoms, be supposed present, recourse must be had to the means recommended to be adopted in the phosphatic diathesis, and alkaline remedies must be carefully avoided. I doubt very much, however, if any treatment will prevent, under these circumstances, the phosphatic diathesis from being sooner or later established.

Oxalate of Lime and Cystic Oxide Calculi. Besides the local and general use of anodynes, attempts must be made in these, as in the last diathesis, to restore the urine, if possible, to its natural state; but with respect to the means to be adopted with this view, I have nothing at present to add to what I have formerly mentioned.

Calculus composed of the Phosphates. It should be our object in this, as in the other different diatheses, to restore the urine as speedily as possible to its natural state. I am sorry, however, to be obliged to confess that I have never been able to accomplish this purpose in a single instance, even after the most fair and persevering trial of almost every remedy that has hitherto been recommended, or that I could devise as likely to effect my object. The consequence has been, that I have never been able to procure more than a temporary relief from suffering by the various exhibition of opiates, &c. The operation of lithotomy, therefore, seems to be the only alternative in this form of the disease. If, however, the case is doubtful, or the patient refuses it, or his situation will not admit of the performance of the operation, recourse may be had to the means formerly pointed out when the nature of this diathesis was treated of in detail.

With respect to the *local* treatment in calculi this will be obviously nearly the same in all the species, and consist in little more than the exhibition of anodynes in some form or other. Hyoscyamus and opium, either alone or combined with astringents, in some cases, as with the uva ursi for example, may be given internally. When thus exhibited, the hyoscyamus is in general to be preferred in the lithic acid diathesis, and opium in the phosphatic. I have, however, seen striking temporary relief produced, even in the cases of phosphatic calculus, by large doses of hyoscyamus combined with the uva ursi. Opium may be also employed in the form of suppository, injection, embrocation, &c. but the form of suppository or injection is perhaps the most beneficial, as well as preferable in other respects. In conjunction with opiates, or, where they cannot be used, the warm bath, fomentations, sitting over hot water, and all the well-known similar means, may be had recourse to. In severe paroxysms I have seen great temporary relief produced by a lotion composed of the *liquor plumbi acetatis dilutus* and tincture of opium, applied to the perinæum as hot as possible, by means of sponges, linen cloths, &c.

The treatment of *Calculi in the Prostate Gland* will, in most instances, from the local character of the affection, be of a surgical nature, there being no known medicinal means by which we can hope either to prevent their formation or future increase; and Mr. Wilson observes, "If these calculi be not very troublesome, our best plan will be to leave them alone, and not to irritate the gland, by the introduction of the catheter more frequently than may be necessary to prevent retention of the urine. When very troublesome, and when they can be felt through the rectum, they may be cut out by an incision, as in the old method of cutting for the stone or the *gripe*, as it was called; but what I should conceive to be the safer practice, they may be extracted by an incision into the gland from the perinæum." * In the case related by Mr. Brodie, before alluded to, in which an abscess in the gland contained a number of these calculi, a large proportion of them was successfully removed from thence and from the bladder by Weiss's forceps.

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* Lectures on the Urinary Organs, p. 356.

Acute Inflammation of the Bladder is a most dangerous affection, and requires prompt means to counteract it as speedily as possible. Blood-letting from the arm (some of the French surgeons recommend bleeding from the foot in preference) to be repeated according to circumstances, accompanied by local bleeding by cupping or leeches, from the region of the pubes, and especially the perinæum, should be resorted to as speedily as possible. These may be followed instantly by warm fomentations, or the warm bath, the injection of emollient fluids into the rectum, &c. Internally, active doses of calomel conjoined with opium may be exhibited, and the bowels may be relieved by laxative clysters. After the more urgent symptoms have been subdued, various counter-stimulants may be applied to the parts above-mentioned; but if blisters be employed, they should be used with caution, and permitted to remain on for a short time only, and afterwards such dressings applied as may tend to keep them open. The urine should be drawn off by the catheter as often as it may be required; but in doing this, great care will be necessary, so as not to increase the pain and sufferings, of the patient. The French surgeons have recommended the injection of mucilaginous fluids into the bladder, with the view of diluting its acrid contents, and soothing the irritation; but I believe the practice has not been generally adopted in this country; in particular instances, however, it seems to be a remedy calculated to afford considerable relief.

In *Inflammation of the Prostate* means similar in principle to those above related are of course to be adopted, though they seldom require to be so generally active. Cupping over the loins, and the application of numerous leeches to the perinæum, and about the verge of the anus, often afford great relief, and check the more urgent symptoms; with these may be employed warm fomentations, or large poultices, to the perinæum, the warm bath, &c. The bowels should be kept open by mild aperients or clysters, and those purgatives likely to irritate the rectum should be particularly avoided.

In the earlier stages of the disease the use of instruments should be avoided as much as possible. When the active symptoms have subsided, much relief is sometimes obtained by the judicious exhibition of sedatives, which may be employed either internally or injected into the rectum; and in this state of the affection, if the catheter can be introduced without irritation, its use may be beneficial.

In *Catarrhus Vesicæ*, and other affections of the bladder and prostate, supposed to be connected with a chronic inflammatory action, especially in their earlier stages, and when the urine is high coloured, and decidedly acid, the means above-mentioned, namely, cupping from the loins, the application of leeches, &c. to the perinæum, will be found particularly serviceable; in the latter, and more passive stages, these remedies can be seldom requisite, at least to the same extent, though even in this state their employment in a more moderate degree may be occasionally useful. In this passive state, gentle astringents combined with sedatives, are sometimes eminently useful; a variety of these have been recommended, but none that I have yet employed surpasses the uva ursi; this either in the form of extract or infusion, combined with hyoscyamus, and persevered in steadily *for a considerable time*, seldom fails to diminish the irritation and quantity of mucus, and thus to mitigate very materially the sufferings of the patient.

Besides the above, numerous other remedies have been employed in this affection, such as madder, camphor, hemlock; blisters, mustard poultices, setons, &c. applied to the perinæum, and inner part of the thighs; various balsamic substances, as, copaiba, cubebs, turpentine, &c. of the effects of many of which I am unable to speak; but from general principles should infer, that whatever is likely to excite irritation will rather increase the mischief. The bowels are to be regulated by gentle purgatives; but saline and acrid remedies of this character in general should be avoided. The diet in this affection should be light and easy of digestion, and free from all stimulating condiments. Moderate exercise will be proper; but the patient should carefully avoid riding on horseback, or in a rough carriage, and in short, fatigue of any sort; and during the winter, and in damp weather, should protect himself as much as possible from the influence of the cold, or, if circumstances will admit of it, migrate to a warmer climate.

In the treatment of *ulceration* of the *bladder and prostate gland,* and indeed in most of the chronic affections of those organs described in the present section, it should be always kept in mind, that it is much easier to do *harm,* than it is to do *good.* In these affections it is impossible to lay down any specific plan of treatment; but the principles stated in the preceding paragraphs should always be kept in view, and the remedies there enumerated be so administered as, on the one hand, to moderate symptoms denoting too much activity; and on the other, to mitigate the sufferings, and support the general health of the patient: and these, joined with such assistance as an experienced surgeon knows how to administer, will sometimes enable a patient to bear up under his sufferings, and ultimately to arrive at comparative health; at any rate they constitute the whole that in his deplorable state can be effected for him by human aid.

In *spasmodic* affections of the bladder, when accompanied by inflammatory symptoms, the usual antiphlogistic remedies should be employed. These may be followed by the use of the warm bath, or warm fomentations, and at the same time opiates may be administered, either by the mouth or in the way of clyster, according to circumstances. If the affection be supposed to be connected with gout, mustard, or other stimulating cataplasms, may be applied to the feet, &c. Some of the foreign surgeons have spoken highly of the juice of the *mesembryanthemum crystallinum*, or *ice-plant*, in this affection, but I am not aware that it has been employed in this country. In retention of urine connected with spasm of the neck of the bladder, Mr. Cline has particularly recommended the muriated tincture of iron to be taken in doses of ten drops or more every ten or fifteen minutes till it produces the desired effect.

In *paralysis* of the bladder particular care must be taken least the urine should accumulate in too great quantity, and by attention to this point, and to the general principles already laid down, the bladder may, in some instances, when the cause is not of an organic nature, recover more or less of its natural powers. When the affection is connected with a general debility of the system, in young or middle aged individuals, the cold bath, and other tonic remedies, may be useful. Should it depend on an affection of the spine, the requisite means to counteract such diseases may be employed; and in some of these cases, the judicious exhibition of stimuli, as electricity and galvanism, the tinct. of cantharides, &c. have been found beneficial; some of the foreign surgeons also have recommended the injection of cold water into the bladder in this affection. The treatment of paralysis of the bladder, however, in all instances, will very much depend on its cause, and the nature of the affection with which it is associated.

To prevent repetition, I have reserved for this place a few brief remarks on the employment of alkaline and acid remedies, and of mercury in chronic affections in general of the urinary organs. The employment of these remedies depends altogether on the properties of the urine. When the urine is *acid*, high coloured, and abounds in the lithates, a little of the *liq. potassæ*, or *carb. sodæ*, may sometimes advantageously form a part of the plan of treatment: when *alkaline* or neutral, which is by far the most frequent, a little lemon juice or muriatic acid; but in general it will be found, that neither the one nor the other of these remedies can be pushed to any extent without increasing the patient's sufferings. Hence there are few chronic affections of the urinary organs in which saline compounds containing a vegetable acid, are not calculated to do much mischief. With respect to mercury, when the urine is acid, occasional doses of blue pill, or other mercurial, may be sometimes used with advantage; but in alkaline conditions of that secretion the effects of this remedy are very doubtful; and when carried to any extent they seldom fail of increasing the irritation, not only by rendering the urine more alkaline, but probably by their pernicious effects on the constitution. In such cases, when the use of mercury seems otherwise indicated, a solution of chlorine or nitric acid may be substituted.

CHAP. II.

Data showing the Periods of Life, Sex, &c. most subject to Calculous Affections, and the Mortality attending the Operation of Lithotomy; with Observations on the Circumstances in which Lithotomy ought or ought not to be recommended.

For the following data respecting the periods of life most subject to calculous affections, and similar circumstances, I am principally indebted to the works of Dr. Marcet and Mr. Smith, before referred to.*

												Consisting of		
												Males.	Females.	Total.
Under 10 years.	Age.	1	2	3	4	5	6	7	8	9	10			
	Cases.	0	1†	17	22	20	14	17	7	25	13	134	2	136
Between 10 and 20.	Age.	11	12	13	14	15	16	17	18	19	20			
	Cases.	11	16	10	5	4	5	2	5	5	2	62	3	65
Between 20 and 30.	Age.	21	22	23	24	25	26	27	28	29	30			
	Cases.	7	3	1	4	4	2	4	2	4	4	34	1	35
Between 30 and 40.	Age.	31	32	33	34	35	36	37	38	39	40			
	Cases.	4	4	3	1	3	5	4	4	3	3	33	1	34
Between 40 and 50.	Age.	41	42	43	44	45	46	47	48	49	50			
	Cases.	4	3	4	4	4	3	2	3	2	8	37	0	37
Between 50 and 60.	Age.	51	52	53	54	55	56	57	58	59	60			
	Cases.	3	3	2	5	1	3	4	3	1	3	28	0	28
Between 60 and 70.	Age.	61	62	63	64	65	66	67	68	69	70			
	Cases.	1	2	4	1	1	2	1	1	3	2	18	0	18
Between 70 and 80.	Age.	71	72	73	74	75	76	77	78	79	80			
	Cases.	0	0	0	0	1	0	0	0	1	0	2	0	2
											General Totals	348	7	355

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* See p. 95.

† No operation.

The foregoing table is taken from Mr. Smith's valuable paper, and represents the number of cases of operation for stone at all ages, which have occurred in the Bristol Infirmary.

The following table, of similar import, though less extensive and perfect, is taken from the same excellent paper. The district is that of which the town of Leeds forms the centre, and the data are taken from the surgeons' books of the Leeds Infirmary:

	Cases.
10 years and under	83
Between 10 and 20	21
20 and 30	21
30 and 40	12
40 and 50	28
50 and 60	21
60 and 70	9
70 and 80	2
	197

197 Consisting of Males 188, Females 9.

During a period of forty-four years, namely, from 1772 to 1816, according to Dr. Marcet, the following is a summary of the returns of cases of lithotomy in the Norfolk and Norwich hospital:

	Consisting of		
	Males.	Females.	Total.
Children under 14 years	227	8	235
Adults	251	20	271
Totals	478	28	506

The following table presents a general view of these data; and, as far as they can be exhibited, of the proportions of stone cases before and after puberty, and of their occurrence in the different sexes:

	Bristol.	Leeds.	Norwich.	Total.	Consisting of	
					Males.	Females.
14 years and under	178	96*	235	509		
Above 14 years...	177	101	271	549		
	355	197	506	1058	1014	44

From these data, therefore, whether taken collectively or individually, it appears, first, that *nearly one half of the whole number of stone cases occurs before the age of puberty;* and from the two first tables, that there is an evident increase in the number of cases about the age of forty years. Secondly, from the general table it appears that the proportion of females to males afflicted with this disease, is only about 1 in 23. The Norwich table appears to show that the proportion of adult females with stone is greater than this estimate, and greater also than that of female children; but the Bristol table is at variance with this conclusion.

With respect to the causes of the greater prevalency of stone before puberty, and about the middle age, these points, I flatter myself, have received considerable elucidation from the remarks contained in the preceding chapters. Hence it will, perhaps, be only necessary to observe here, by way of recapitulation, that the greater prevalency before puberty seems to depend chiefly on the greater tendency to urinary derangements at this age, and the comparative narrowness of the urethra, by which the escape of the calculus, when once formed, is rendered more difficult. Between the age of puberty and forty or fifty there seems, in general, to be less tendency to urinary derangements than at any other period of life, and hence the comparative infrequency of calculous affections. But about the middle period of life, when the powers of the constitution become stationary or retrograde, and gout begins to make its inroads into the system, a disposition to urinary disease is very apt to again manifest itself, particularly in those who inherit a tendency to gouty affections, or are otherwise predisposed to them, and hence the greater frequency of stone at this period.

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* Estimated partly from the proportions in the Bristol tables.

As to the second point, so clearly established by the above data, namely, the infinitely greater frequency of calculous diseases in the male than the female sex, as well before as after puberty; this can be only referred, at present, to the differences existing between the length, &c. of the urethra in the two sexes, the shortness of the female urethra being favourable to the escape of the calculous nuclei. Something, also, may be ascribed, at least in the adult state, to the more regular and sober habits of females.

I should in this place make some remarks on the frequency of calculi in different countries, and in different districts of our own country; also on the comparative frequency of the disease in modern and ancient times; but the data on these points are, in general, too imperfect, at present, to permit us to arrive at any satisfactory results. For what is known on these subjects, we are chiefly indebted to Dr. Marcet and Mr. Smith, to whom, therefore, I refer the reader. It may, however, be observed, that warm climates in general, and even particular districts of our country, as Hereford (in the hospital of which county there has not been a single applicant for stone since its erection in 1775), appear to be remarkably exempted from these affections. In Hanover also, and in certain provinces on the Rhine, the stone is said to be almost unknown.* On the contrary, other districts, as that surrounding Norwich, are exceedingly liable to these affections. Mr. Hutchison has shown that the disease is of rare occurrence among seafaring people.† With respect to the comparative frequency of the disease in ancient and modern times, the most perfect data seem to prove, that the disease is more rare at present than formerly. These facts are very important, but at present they do not admit of a satisfactory explanation.

After these observations, which I trust will be considered as a sufficient illustration of our data, we come to make a few remarks upon a very important question, connected with calculous affections, which medical men are frequently called on to decide; namely, whether the operation of extraction be immediately necessary, or whether it can with propriety be deferred for some time, or even altogether. The observations advanced on the different diatheses, in the former part of this volume, will enable us to speak with greater certainty on these points than could be done previously; but before we proceed, perhaps, it will not be amiss to inquire briefly into the mortality attending the operation of lithotomy.

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* See Traite des Maladies de la Vessie, &c. chez les Vieillards, par S. Ch. Soemmering. p. 62.

† Med. Chirurg. Trans. ix. p. 443.

The following is a summary of the most perfect data we possess on this subject. The first and most complete table is taken from Mr. Smith's paper, so often quoted, and represents the mortality from lithotomy, as it has occurred at different ages in the Bristol Infirmary:

Age.	Rate of Mortality.	
10 years of age & under	1 in $4\frac{4}{9}$	
Between.... 10 & 20	1 .. 6	
.... 20 .. 30	1 .. 7	
.... 30 .. 40	1 .. 5	
.... 40 .. 50	1 .. $3\frac{1}{3}$	
.... 50 .. 60	1 .. $4\frac{1}{3}$	
.... 60 .. 70	1 .. $2\frac{1}{4}$	
.... 70 .. 80	1 .. 2	
Mean at all ages ..	1 in $4\frac{1}{4}$	or Before puberty,* nearly as 1 in $4\frac{3}{4}$ After do,* nearly as.... 1 in $4\frac{3}{14}$.

* Partly estimated.

The following table is also taken from the same paper, and refers to the Leeds district. There occurred in the Leeds Hospital,

	Cases of Lithotomy.	Died.	Rate of Mortality.
from 1767 to 1777	.. 24 of which	2	or 1 in 12
.... 1777 .. 1787	.. 62	8	.. 1 ... 7¾
.... 1787 .. 1797	.. 23	3	.. 1 ... 7⅔
.... 1797 .. 1807	.. 42	7	.. 1 ... 6
.... 1807 .. 1817	.. 46	8	.. 1 ... 5¾
	Mean at all ages		.. 1 in 7⅕

According to Dr. Mareet, the mortality in the Norwich Hospital, for the last 40 years, has been

Before puberty, as .... 1 in 18
After puberty .... 1 .. 4¾

Or *generally* at all ages .. 1 in 11⅜

From these data it appears, that the mortality from lithotomy has been much less in the Norfolk Infirmary than in either of the others, particularly in the Bristol Infirmary. In also appears, from the Norfolk table, that the *general* risk is less in children than in adults, in the proportion of about four to one; but, on the other hand, from the Bristol table, the chances seem nearly equal. These differences are at present inexplicable; but, I think, from the greater number of cases occurring in the Norfolk Hospital, and other circumstances, that the data furnished by that Hospital present the most accurate estimate of the relative mortality, before and after puberty, from the operation of lithotomy. If we take the mean of all these data, we shall probably approach very nearly the ratio of mortality, as it occurs from lithotomy, at all ages, over the whole kingdom:

Mean at all ages, in the Bristol Infirmary ..	.. 1 in $4\frac{1}{4}$
Do. in the Leeds..........	1 .. $7\frac{4}{5}$
Do. in the Norwich	1 .. $11\frac{3}{8}$
Mean ratio of mortality....	1 in $7\frac{3}{4}$ very nearly.

We come now, in the last place, to make a few remarks upon the circumstances which ought to be taken into account, in determining our opinion with respect to the propriety or necessity of the operation of lithotomy.

1. The operation of lithotomy should in general be performed either immediately or as soon as possible, *a*, in all cases of calculus occurring before puberty, of whatever species they may be; and, *b*. whenever the phosphatic diathesis is distinctly ascertained to be present, or even when the urine abounds with pale coloured lithate of ammonia.

a. Whenever a calculus, no matter of what species, is ascertained to exist in the bladder before puberty, there can, I think, in general, be but one opinion respecting the propriety of removing it. The reasons are so obvious, that they scarcely need be stated; it will be sufficient to remark, that a long series of inevitable suffering will be thus prevented, the risk of a fatal result diminished, and the chance of a perfect cure rendered greater than in a more advanced period of life. In general it will be better that the operation should be performed immediately; but if the lithic diathesis be steadily present, if the state of the general health be good, and if the sufferings in consequence be moderate, the operation may be delayed till towards the age of puberty, as, from the favourable changes which commonly take place at this period, there will be less risk of the disease returning: but, if the general health appears to have given way, and the patient suffers a great deal of pain and irritation, as is most frequently the case, delays will be exceedingly dangerous. *b.* As to the second point, I give it as my decided opinion, that in all cases where the phosphatic diathesis is fairly established, the operation is the only alternative, and the sooner the better. This opinion is founded on the facts sufficiently, I presume, established by the data brought forward in a preceding part of this volume, from which it appears that this diathesis uniformly *succeeds* to all the others; that it never changes when a calculus exists in the bladder, so as to leave room to hope for a better; consequently that it is the last and worst stage of the disease, and will certainly sooner or later terminate the wretched existence of the patient, if permitted to proceed. The only alternative in such cases, then, is, evidently, to remove the calculus as speedily as possible, before the constitution becomes too deeply affected, and particularly before the bladder becomes diseased, which is one of the most certain and distressing consequences of this species of calculus. Nearly the same remarks apply when the urine is loaded with pale coloured lithate of ammonia, or the disease appears to be in a transition state; as, in this case, I doubt very much, from what I have seen, if the lithic diathesis can ever be fairly re-established, at least while a calculus exists in the bladder.

2. The operation of lithotomy may be frequently postponed under the following circumstances; namely, when the calculus is small or of moderate size, and of the lithic acid species, and when the lithic acid diathesis is steadily present, and particularly if the patient be in the prime of life, the constitution, &c. sound, and the sufferings comparatively moderate; provided always that the patient will conform to the necessary plan of regimen, &c. calculated to remove or diminish the diathesis, and thus to prevent the increase of the calculus.

It has been stated in a preceding chapter, that a lithic acid calculus has been frequently known to exist in the bladder for a very long time, without producing much uneasiness; it is evident also, that if the urine can be preserved in a perfectly natural state, a calculus thus situated can receive no increase in bulk; but it has been rendered probable, that these two circumstances co-exist; namely, that a perfectly natural condition of the urine is generally accompanied by freedom from pain and irritation, in this, as well as in all other species of calculus: under these circumstances, therefore, I should feel great hesitation in recommending a person in the prime of life, with perhaps a family of children depending upon his exertions, to risk his life by submitting to the operation of lithotomy; at least, till it had been ascertained, that the means proper for rendering the urine natural, &c. had been resorted to, and had failed; or if they had been found temporarily beneficial, that they could not be persevered in. But if the proper means have been resorted to at an early period of the affection, which is of the first importance; and if they prove adequate to restore the natural condition of the urine, and thus prevent the increase of the calculus; and if patients will conform to the necessary regimen, &c. with the view of preserving matters in this state, I am fully satisfied, from what I have seen, that in by far the greater number of instances, the subjects of this disease may pass a great many years, perhaps a whole life, with a small or moderately sized lithic calculus in the bladder, with comparatively very little suffering; and that thus the necessity of a cruel and dangerous operation may at least be put off till a period when life may be of less consequence, or perhaps altogether. On the contrary, if a patient be not sufficiently a stoic to adhere to the restrictive regimen, and other necessary means; or if these do not give him ease, or restore the natural condition of the urine; or if his situation in life or daily occupation expose him to violent exercise, or other unfavourable circumstances; I wish it to be distinctly understood, that in such cases the above advice *is inapplicable, and the retention of the calculus dangerous.*

How far the above rules are applicable to the mulberry and cystic oxide calculi, I do not know. The rough surface of the mulberry calculus will probably produce, in most instances, too much irritation to permit it to be retained in the bladder for any length of time; but, with the exception of this circumstance, I have the strongest reasons for believing, that this calculus is subject to nearly the same laws as the lithic acid species.* Of the cystic oxide calculus, I can say but little, though I fear from the severity of the constitutional derangement present, and the rapidity with which the calculus is likely to increase in bulk, that its retention in the bladder for any great length of time would be impossible.

In conclusion, it may be observed, that I wish the above remarks to be understood in a general sense, and as totally independent of surgical reasons or difficulties, with which I have nothing to do; but which must likewise be obviously taken into account, in all cases of calculus in the bladder.

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* I have already alluded to Mr. Wilson's corroboration of this opinion, who also states, that this species of calculus, notwithstanding its roughness, frequently produces comparatively little suffering. Lectures on the Urinary Organs, p. 235.

Solvents for the Stone. In a work of the present character, my readers will naturally expect, that the subject of *solvents* for the stone, which formerly so much occupied the attention of the profession, should be mentioned. When the first edition of this work was printed, I knew nothing about the matter, and, therefore, avoided it altogether. Since that time I have seen two or three attempts made to dissolve the stone by injecting the solvent into the bladder. The results, I am sorry to say, were by no means such as to impress me with any very favourable notions of the general practicability of this plan; and, indeed, when the very weak state of the solvent that can be thus employed is taken into account, the consequent length of time necessary for continuing the experiment, and above all the refractory nature of certain calculi; I confess I am very much disposed to doubt if any solvent at present known, can, in the great majority of instances, be ever so administered as to produce the desired effect: and this I believe is the general opinion on the subject. With respect to the action of solvents taken by the mouth I have at present still less faith. Nothing, however, is impossible; and I am willing to encourage the hope, that hereafter some more efficacious means than any that have yet been attempted will be discovered.

CHAP. III.

Recapitulation, containing practical Rules for determining the Nature of the Affection, and its appropriate Remedies, from the Properties of the Urine, and other Symptoms.

It is my intention to offer, in the present chapter, what may be considered as a general review of the whole subject, and particularly of some points imperfectly discussed in the preceding pages, under the following heads:

1. *Increased or diminished quantity of the urine.*
2. *Colour and transparency of ditto.*
3. *Specific gravity of ditto.*
4. *Acidity and alkalinity of ditto.*
5. *Urinary sediments.*
6. *Bloody urine.*
7. *Mucous and purulent urine.*
8. *Suppression and retention of urine.*
9. *Incontinence of urine.*
10. *Pains of the back and loins.*
11. *Irritable bladder.*

To enable us to form a correct notion of the variable properties of the urine, it is necessary that we should accustom ourselves to observe it in some regular and uniform manner. For this purpose I prefer a transparent cylindrical vessel, such as a common phial, of not less than one inch, nor more than two inches in diameter, and from six to eight inches long. In such a vessel all the sensible properties, both of the urine and its deposites, can be distinctly ascertained, while in an opake vessel the most experienced eye can hardly determine either in a satisfactory manner.*

When the object is more particularly to determine the operation of the kidneys, the urine *first passed in the morning*, should be chosen for examination. The urine passed after a principal meal, as *after dinner*, is liable to be considerably influenced by the derangements of the digestive functions, on the nature of which it will frequently throw considerable light; while, for the same reasons, it is less favourable for inquiry into the peculiar operations of the kidneys. The effects produced by *time* on the urine are also frequently very instructive; hence it should be always put by for at least twenty-four hours, and the nature of the changes it undergoes be accurately noticed. Patients subject to urinary diseases should be also directed to make these observations for themselves, and to keep two or three glasses in their bedrooms for that purpose.

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* Except in the cases of *pink* and *yellow* urine, noticed below, and, perhaps, in one or two other appearances, which are best seen in an *opake white vessel*, or by partially covering the phial with a piece of white paper.

In the examination of any given specimen of urine, the first general question to be determined is, whether the disease be one of the *secreting* or the *containing* organs; that is to say, whether the kidneys be the seat of the disease, or the bladder, &c.; or whether both be implicated in the affection.

When the urine contains neither mucus, pus, nor blood, it may be concluded in general that the kidneys are the source of the disease: when mucus or pus are present, the containing organs, and probably the bladder, are certainly affected: when the urine is unnatural at the same time that it contains mucus or pus, as is most usually the case, both the kidney and bladder are implicated in the affection.

Having settled this general, and often very important preliminary point, the urine may be next considered as to its

1. *Increased or diminished Quantity.* The standard quantity of urine voided by a healthy individual, in twenty-four hours, has been variously estimated; and, indeed, when we consider the nature of the subject, we can scarcely wonder at the difference of opinion respecting this point. The celebrated Haller supposed the quantity to be as high as 49 oz. Dr. Bostock thinks the estimate of Rye more correct, who fixed it at 40 oz. I am disposed to think that even this is too high, and that in a person who does not drink more than the simple wants of nature require, 2 lbs. or 32 oz. is a fair average, taking the whole year together. Generally speaking,

the quantity of urine is greater in the winter than the summer; and besides this, it is liable to be influenced by a variety of causes, the *modus operandi* of which is sufficiently obvious; so that, perhaps, it is impossible to hope for any thing like a standard that shall be universally applicable, and every individual must to a certain extent be measured by his own standard.

Generally speaking, nothing can be more opposite than the conditions of the system, and consequently principles of practice indicated by a diminished or increased flow of urine: thus a diminished flow of urine usually accompanies active inflammation or an inflammatory state of the system in general; while on the other hand an increased flow of urine, or *diuresis*, very constantly accompanies those diseases connected with a peculiar state of nervous irritability, as hysteria; it may also be produced by certain passions of the mind, as fear, &c. Hence an increased and diminished flow of urine are symptoms of primary importance in all diseases in which the urine is concerned, and whatever may be the disease seldom fail of furnishing us with a clue to the principles on which it is to be treated.

2. *Colour and Transparency of the Urine.* The colour and transparency of the urine are often points of considerable importance in urinary affections. The natural colour of the urine *deepened* is a necessary consequence of a diminished flow of urine, whether from natural causes or from disease. The

natural colour of the urine inclining to *red* denotes fever or inflammation. Urine of a *pink* colour, which is rather uncommon, occurs in cases of obstinate dyspepsia, accompanied by organic disease. Urine of a *yellow* tint denotes jaundice. These two last tints can hardly be seen by transmitted light, but are best observed in an opake shallow *white* vessel. The above tints are understood to apply to urine of the ordinary degree of transparency after cooling, and which does not contain sediments. Urine which, after cooling, assumes *a copperish hue, and becomes remarkably transparent,* is generally acid, and the circumstance denotes a very strong tendency to the deposition of lithic acid in the form of gravel, &c.; it is a formidable appearance, and requires immediate attention. The urine is frequently of a yellow or citron tint and transparent, when there is a tendency to the deposition of oxalate of lime; but this is, perhaps, hardly striking enough to be characteristic of that circumstance. Urine of a pale yellow or green cast, transparent both when past and on cooling, and having a sweetish hay-like smell, commonly denotes diabetes. If of the same tints, but opalescent when past, and having a strong and very peculiar smell (not to be described) the cystic oxide diathesis may be suspected. If of a pale whey-like appearance, and opalescent when past, with a strong urinous smell, it is commonly alkaline, or speedily becomes so on cooling, and a tendency to the deposition of the phosphates is denoted.

The above are some of the most striking points connected with the colour and transparency of the urine; but I regret to say, that there are a great many more sufficiently characteristic of different affections, which cannot be described so as to be made intelligible to others, and particularly to those who have not made these subjects their study.

3. *Specific Gravity of the Urine.* The specific gravity of the urine is as variable as the quantity, and, generally speaking, follows, though inversely, pretty nearly the same law; that is to say, the greater the quantity of urine the lower (in health) the specific gravity. We mentioned the attempts that have been made to fix an average quantity of urine, and similar attempts have been made to fix an average specific gravity, and probably with about the same degree of success. I have supposed the average point in question to lie between 1·010 and 1·015, and this is probably not far from the truth, taking the whole year together; though it is to be borne in mind, that in summer it will be generally found higher and in winter lower than these points.

Urine of much lower specific gravity than 1·010, and at the same time transparent and of the natural colour much diluted, commonly denotes a tendency to spasm: or when opalescent and whey-like, a tendency to alkalescence, or a deposition of the phosphates. When of considerably higher specific gravity than 1·015, and of the natural colour, much deepened or inclining to red, a tendency to fever, or some derangement of the digestive functions, and especially of the hepatic system, is usually denoted. When the specific gravity of the urine is as high as 1·030, and it is at the same time pale coloured and transparent, diabetes may almost certainly be pronounced to be present. When the specific gravity of pale coloured urine varies between 1·020 and 1·030, and the smell is not remarkable, nor the quantity very inordinate, an excess of urea may be suspected.

4. *Acidity and Alkalescency of the Urine.* In forming our judgment of these most important properties of the urine, reliance should be hardly ever placed on a *single trial*, but, as in all other instances, the *general* character of the secretion should be chiefly attended to. The test commonly employed for acidity of the urine is litmus paper, and it should be remembered, that healthy urine does and ought to redden this paper; not, perhaps, by means of the free acid it contains, but of the lithate of ammonia and phosphate of ammonia present, both of which salts, when in solution, having been found to possess this property. In judging of the acescency of the urine the *immediate* effects only produced on the test are to be noticed. The colour of the litmus is reddened, and indeed nearly destroyed by almost all natural urine, after the paper has been dipped in it, and exposed for some time to the air. This arises from the decomposition of the salts above-mentioned, and of the muriate of ammonia, from all which, the ammonia, under the above circumstances, readily escapes, thus leaving

the acid behind to exert its peculiar properties on the paper.

To enable one to judge with advantage from the effects produced by the urine on litmus paper, considerable practice is necessary. An experienced eye can determine with tolerable certainty from the tint produced, and the colour and transparency of the urine, whether the reddening effect be produced by the salts above-mentioned, or whether it depends in part on the presence of a *free* acid; but to an inexperienced eye, the whole will appear confusion. To those, however, who have not studied this subject, and who wish to acquire information, I can only recommend *practice*, as it is not possible to convey by words any thing like precise information on the point in question. A very delicate test of the presence of a *free* acid in the urine, is the precipitation of the lithic acid from it in the solid state, and the quantity of free acid present may be commonly judged of pretty nearly from the *time* required to produce this effect, and the *quantity* of lithic acid precipitated. If the lithic acid be not precipitated till after some time, or till the urine begins to cool, the quantity of free acid is generally trifling; if the lithic acid on the contrary be precipitated before the urine quits the bladder, the proportion of free acid is much greater, and a more formidable disease is denoted.*

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* In particular states of the system an acid seems to be generated during the putrefaction of the urine, and in this state the lithic acid will be also precipitated, but a mistake can hardly occur from this circumstance.

The most delicate test of the alkalescence of the urine, is litmus paper that has been previously reddened by a very weak acid. Turmeric paper is much less sensible, and when urine sensibly affects this test, its alkaline properties, which generally depend on ammonia, can, for the most part, be readily determined by the smell. For the urine to be alkaline, when first past, is comparatively a rare occurrence; and in slighter cases, in estimating the degree of this state of the urine, the *time* required before the urine begins to indicate alkalescence should be always taken into account. Alkaline urine is generally pale coloured, and more or less turbid: its specific gravity is variable; generally moderate or low, but occasionally rather high; it frequently abounds in the phosphates, particularly the triple phosphate of magnesia and ammonia; and when it deposites the alkaline lithates these are generally pale coloured, and sometimes quite white.

When the urine is steadily acid, high coloured, and concentrated, the state of the constitution is generally such, that if the other symptoms require it, mercurial and saline remedies may be given freely, and with safety and advantage. But when the urine is alkaline the case is very different; here mercurial and saline remedies, if pushed to any extent, almost invariably do much harm. By saline remedies I mean more especially those saline compounds which contain a *vegetable acid.* The most effectual method of rendering the urine *alkaline,* and of keeping it so, is to give repeated small doses of saline compounds containing a vegetable acid, such as the Rochelle salts, &c. Hence when the urine is already alkaline, the mischief that the exhibition of such remedies is calculated to produce, must be sufficiently obvious; and, indeed, no one but those who have attended to the subject can hardly conceive the bad effects produced by remedies of this description in certain diseases of the urinary organs. When the urine is alkaline, should the use of effervescing saline remedies be indicated, some mineral acid, such as the sulphuric, should be employed.

In all *urinary diseases* the acidity and alkalescence of the urine are of the utmost importance, and should be carefully studied in all their forms and grades by those who practise in these affections; and even in other affections, in which they are to be considered as *symptomatic* only, their importance is always very considerable, as they indicate peculiar states of the system, which the physician ought to be acquainted with, and which, in many instances, he cannot discover so easily from any other source.

5. *Urinary Sediments.* By urinary sediments I mean here, those derived exclusively from the urine, and which, in general terms, may be considered as consisting of the alkaline lithates and earthy phosphates. The most frequent ingredient of urinary sediments of the former description is the lithate of

ammonia; this, as we have attempted to show, appears under three forms, or rather assumes so many different colours, viz. the *yellow*, the *pink*, and the *red*, the latter of which is composed of a mixture of the two former. Of these the red variety of sediment is most frequent, and occurs during phlogistic fever, gout, &c. in individuals otherwise healthy, and accompanies acidity of the urine. The yellow sediment, especially when it approaches to white, is more rare than the red, and denotes a tendency to alkalescence of the urine. The pink sediment is more rare than either, and generally denotes some organic or deep-seated affection, more especially of the liver. All these sediments are held in solution in the urine when first past, and are deposited on the cooling of that fluid; by heating the urine again, however, to its natural temperature, they are all readily redissolved, and this may be considered as their characteristic property. The sediments composed of the earthy phosphates are white, and are always deposited by urine either actually alkaline, or having a tendency to alkalescency. There is, however, one form of sediment *perfectly white*, which is deposited by *acid* urine. This consists chiefly of the *lithate of soda:* of this I have seen two or three instances only, and in one of these, enormous quantities of this substance were passed in the form of powdered chalk, and occasionally like a paste composed of chalk and water.

Besides difference of colour, urinary sediments assume a variety of other appearances, which are highly instructive as indicating particular states of disease, but which I regret to say cannot be described so as to be rendered intelligible to another; all I can do, therefore, in this and similar circumstances, is to recommend a careful study of the subject to those who wish to acquire a knowledge of urinary diseases in general, and to assure them, that their labour, on this point in particular, will be amply repaid.

6. *Hæmaturia, or Bloody Urine.* The source of blood in the urine may be various, and is often very obscure; this point, however, if practicable, should be determined in the first place, and, perhaps, the following observations will throw some little light on the subject.

When the blood is derived from the kidney it is generally equally diffused throughout the whole urine: on the contrary, when derived from the bladder, the blood, for the most part, comes away in greater or less quantity at the termination only of the urinary discharge, the urine having previously flowed off nearly pure. In the former case also, coagulated fibrin, in the shape of *worms*, and which have been moulded in the ureter, and subsequently washed out by the urine, are not unfrequently met with; and when these appear the diagnosis is commonly unequivocal. So much may be inferred from the mere appearances of the blood; but when there is a sense of heat and weight, accompanied by more or less of pain in the region of the kidney; when urinary calculi have been known to descend from the kidney, and there are symptoms of the presence of others, while those of disease or calculus in the bladder are wanting, the hæmorrhage may be fairly supposed to come from the kidney or ureter. On the contrary, when there are evident symptoms of stone in the bladder, or other disease of that organ, or the prostate gland, and the kidney is not affected, the bladder may be safely considered as the source of the hæmorrhage. When the blood comes away *guttatim* without the urine, it may be supposed to come from some part of the urethra. In this case, however, the blood occasionally flows backwards into the bladder, and thus produces some uncertainty as to its origin.

The loss of blood by the urethra is seldom so large as to be in itself dangerous, though some forms of the affection are more serious than others. One very troublesome, and sometimes dangerous consequence of great hæmorrhage into the bladder is the formation of a coagulum in that organ, which, by causing retention of urine, and other distressing symptoms, often produces alarming consequences, especially in old people in whom the prostate is diseased. Another unpleasant consequence of the presence of blood in the bladder is the formation of a nucleus, round which calculous matter sometimes concretes, and thus the foundation of urinary calculus is laid. Hæmorrhage from the bladder is also occasionally a distressing and formidable symptom in diseases of a typhoid character, scurvy, &c.

The treatment of hæmaturia will of course depend on its seat and cause. Hæmorrhage from the kidney, when occurring in a young subject, and attended by inflammatory symptoms, strong pulse, &c. will sometimes require abstraction of blood, either generally or locally, and the usual antiphlogistic treatment. On the other hand, when accompanied by symptoms of debility, as in typhus fever, or scurvy (in the latter of which the urine is commonly alkalescent), tonic and astringent remedies, such as the mineral acids, &c. will be proper. In ordinary cases, when there are no striking symptoms either of excitement or debility, and when the cause is of a mechanical nature, small doses of balsamic remedies, and particularly copaiba, have been strongly recommended by some practitioners, while others again have extolled highly the effects of the *tinct. ferri muriatis.* In all cases, rest in the horizontal position should be attended to as much as possible, and the patient should carefully abstain from all exciting causes, otherwise no remedy whatever can be expected to produce much good.

One of the most formidable cases of hæmorrhage from the kidney that I ever saw, and which baffled for a long time every means that the most experienced practitioners could devise, yielded almost immediately to colchicum, and the use of a strong infusion of uva ursi, and the gentleman continued tolerably free from the affection for nearly two years; latterly, however, it has returned again in a slight degree. The cause of the affection in this case was very obscure, as there were no symptoms of calculus in the kidney, nor did he inherit gout, though he had had one very slight attack of this just before I saw him, which led me to recommend colchicum. In another very severe case of this description, the above remedies, and every thing else that could be thought of, failed. This gentleman was in the prime of life, and had for some time suffered almost constant pain in the region of the kidney. He resided in the country, and a short time after I last saw him, died rather suddenly, but from what cause I do not know. In this case I think it very probable, that there was some very extensive disease in the kidney, probably of a fungous character, as he never had been subject to calculous affections, and could not trace the affection to any particular injury, &c. In another instance of obstinate hæmaturia the bleeding was constantly preceded by a shivering fit.

7. *Mucous and purulent Urine.* As a general rule it must be sufficiently obvious, that when the urine contains a large quantity of mucus, the bladder must be affected; for the kidneys (although they secrete a mucus, under particular circumstances), are probably not capable, on account of their limited

magnitude, of secreting any great quantity of that fluid. There is, however, a species of secretion which is usually called mucus, and which, for want of a better name, may be distinguished by that term, which is frequently thrown out in great abundance by the kidneys, when disorganized, or containing cysts. This may be sometimes distinguished by its peculiar appearance, and by its property of undergoing a sort of imperfect coagulation, or gelatinization like fibrin, of which it seems to be a modification. In these cases the urine is generally albuminous from its containing the serum of the blood in solution, and is frequently alkalescent, or speedily becomes so. This alkalescence of the urine seems to depend, in part at least, upon the decomposition of the urea, by the fixed alkali contained in the mucus above-mentioned. In ordinary cases, and when the mucus is not in very large quantity, this change does not take place till after the urine is voided; but in severe and protracted cases, the changes take place in the kidneys themselves, or in the bladder, and thus the patient's sufferings are much increased by the acrid state of the urine. In the earlier stages of this affection, the urine, though not absolutely transparent, is nearly so, or becomes so on standing; but in the advanced stages, the secretion frequently puts on more of a purulent character, and the urine becomes opake. In some cases of decidedly purulent urine, though the pus itself be alkaline, the urine is strongly *acid*. In such cases it may be generally inferred, that the pus is derived from an abscess in the neighbourhood of the kidney, or at least that the kidneys are only partially affected.

Nearly the same remarks are applicable in those cases where the bladder is affected. In a healthy bladder, when there is any foreign body, as a calculus, for example, irritating it, the natural secretion of mucus is increased. In such cases the mucus, having its properties apparently but little changed, comes away diffused through the urine, rendering it slightly turbid. After a time the mucus sinks to the bottom, where it adheres together in a mass, and cannot be again diffused through the urine without much shaking; and sometimes it is so tenacious, that on inverting the bottle in which it is contained, it will be seen to form strings extending its whole length. Under these circumstances, and where there are no other facts to which the appearances can be decidedly referred, the presence of a stone in the bladder is rendered very probable. When the quantity of mucus is greater than can be accounted for on the above supposition, and the urine, though *acid*, be albuminous, there is reason to suspect the presence of more or less of inflammatory action in the coats of the bladder, such as is present in the earlier stages of catarrhus vesicæ, and which may generally be advantageously treated by local depletion. When the quantity of mucus is very great, and comes away in large masses; when the urine is white and whey-like, and never becomes quite clear on standing, or deposits a pulverulent pus-like matter besides the mucus, and which is again easily diffusible through the urine; when this secretion is alkalescent and fœtid, and contains blood, there is reason to suspect the presence of disorganization, or disease of the coats of the bladder, in the effects of which the kidneys and constitution generally participate, and which will almost certainly never terminate but with the life of the patient.

In the affections of the bladder above-mentioned, the prostate gland almost always more or less participates, so that it becomes difficult to distinguish the peculiar secretion of that organ; but in some cases where this gland is irritated from any cause, its peculiar secretion becomes increased in quantity, and may, by its appearance, be detected in the urine when first voided. In other instances, the quality of the secretion is much altered, and in such cases the quantity of the depraved mucus is very great. Generally speaking, when this gland alone is diseased the urine is acid, at least, in the early stages of the affection; in other instances, when it is secondarily affected, the urine will be frequently found in an unnatural state, and most probably alkaline; for an alkalescent condition of the urine is almost always observed to produce much irritation in this organ and its immediate vicinity.

In the above sketch I have endeavoured to present my readers with a view of the most prominent particulars connected with a mucous and purulent condition of the urine; but I regret to say, that by far the greater part of what I have observed on the subject cannot be described so as to be rendered intelligible. There is no good chemical test of easy application, that will enable us to distinguish pus from mucus, and, perhaps, the best method at present known, is that pointed out by Dr. Young, which is founded on their different optical properties.*

8. *Suppression and Retention of the Urine; Urinary Fever.* In *ischuria renalis,* or suppression of urine, the functions of the kidneys are more or less suspended or destroyed, and the urine ceases to be separated. In retention of urine the kidneys perform their office as usual, and the urine makes its way into the bladder, but from some cause it cannot be passed off from that organ. The symptoms attending these two affections are so different that they can hardly be mistaken, and in all doubtful cases the nature of the affection can be readily determined by the introduction of a catheter into the bladder.

Suppression of urine may be partial or entire, and may depend on a variety of causes; these, however, in general, may be considered as of three kinds, inflammatory, spasmodic, and mechanical, and the symptoms will vary somewhat according to the nature of the cause. In suppression of urine, from whatever cause, there is always more or less of fever, accompanied by thirst and frequently an urinous taste in the mouth. The whole body also usually exhales an urinous smell, not only perceptible to the patient himself, but to others. As the suppression continues, hiccup, with nausea and vomiting take place, to which generally succeed, if the flow of urine does not soon return, a difficulty of respiration, attended by coma, convulsions and delirium, and death speedily closes the melancholy scene.

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* Introduction to Medical Literature, p. 546.

When suppression of urine is accompanied by, or depends on inflammation of the kidney, the symptoms will partake more or less of the character of those already described as produced by that affection. When the signs of inflammation are absent, and the patient has been subject to gout, or if a female, to hysteria, the suppression may be supposed to depend, in part at least, on spasm. The presence of a mechanical cause may be suspected, when the person has been previously subject to calculous affections, &c. Generally, however, in this latter case, the effects cannot be ascribed altogether to the simple operation of the mechanical cause, but in part also to the inflammation or spasm, or both, which it is liable to produce, and the affection thus assumes a mixed character.

Suppression of urine, when complete, and of an original character, or supervening on any acute disease, for the most part, proves fatal. But there are many extraordinary cases on record, in which, in suppression of urine a vicarious discharge, more or less resembling urine has taken place by sweating, vomiting, stool, &c. and the patient under these circumstances has survived a long time, and even ultimately recovered. These instances have generally occurred in females of a nervous irritable temperament, in whom, for the most part, all such extraordinary deviations from nature take place.

From what has been said it will be readily understood, that the treatment of suppression of urine will depend chiefly on its cause, and the nature of the symptoms with which it is associated. When combined with inflammation of the kidney the active antiphlogistic means, pointed out in that affection, will be required. When of a spasmodic character, the chief reliance will be placed on antispasmodic remedies, conjoined in chronic or partial forms of the affection with diuretics or tonics; or if associated with gout, stimulating cataplasms may be applied to the feet, &c. When evidently connected with a mechanical cause, as calculus, recourse must be had to the means recommended in such affections, and at the same time care must be taken to keep down as much as possible the more active symptoms of inflammation, &c.

In *retention* of urine there is always more or less of pain and uneasiness in the region of the bladder, accompanied for the most part with an urgent desire to pass off the urine. The distended bladder also forms, in most instances, a swelling above the pubes, not only perceptible to the touch, but sometimes even to the eye; and the drawing off of the urine by the catheter, if this can be effected, always gives great and immediate relief to the patient's sufferings.

Retention of urine may proceed from inflammation, spasm, or mechanical obstruction at the neck of the bladder, or from a combination of these causes. Sometimes it depends on paralysis, or other affections of the bladder, such as a preternaturnal thickening of its coats, &c.; in short, there is hardly any affection liable to be produced by such a variety of circumstances, or that requires more careful attention and study on the part of the surgeon, within whose province the treatment of this affection usually depends.

Retention of urine, when complete, and permitted to continue for some time, almost always ends fatally; either by acting on the kidneys and producing suppression, or by terminating in rupture, gangrene, &c. of the bladder. Even when permitted to exist in a less degree for any length of time, it is very apt to terminate in partial paralysis, or other distressing affections of that organ.

As retention of urine depends on such a variety of causes, many of them belonging exclusively to the surgeon, of course the treatment must be very various. Generally speaking, when inflammatory symptoms are present, the usual well-known means for removing them must be speedily had recourse to. If the retention depends on a cause of a spasmodic character, in conjunction with warm fomentations, &c. sedatives, either internally or by way of clyster, will be useful; and in spasm of the neck of the bladder in particular, the *tinct. ferri muriatis* may be taken in doses of ten or fifteen drops every ten minutes, till the effect be produced. When these means fail, and when the retention depends on a mechanical cause that cannot be removed, and the catheter cannot be introduced, so as to draw off the urine, recourse must be had for immediate relief to puncturing the bladder.

9. *Incontinence of Urine,* like suppression and retention, depends on a variety of causes. In early life it is often associated with some tendency to urinary disease, and very frequently a disposition to gravel; or sometimes, as in young females, with constitutional irritability and weakness. In advanced life, this affection is almost always associated with some organic or other affection of the neck of the bladder, or prostate gland.

Incontinence of urine in children takes place, for the most part, in the night only, and while they are sleeping; and if close inquiry be made it will be generally found, that under these circumstances the urine is passed off voluntarily under the influence of a dream. In such cases I have uniformly found, on examining the urine, some unnatural property of that secretion, and most generally a strong disposition to, or actual deposite of gravel. Hence I have been led to infer, that in this species of urinary incontinence, the acrid properties of the urine are chiefly in fault, and that these, favoured, perhaps, by the position of the body, and probably also the morbid sensibility of the bladder, excite so vivid an impression on the imagination as actually to lead to a voluntary discharge of the urine. In this form of incontinence of urine, mere habit, and particularly the custom of lying on the back, has considerable effect in keeping up the disease, and in some individuals, in whom the original cause has been long since removed, the affection seems to occasionally recur from this circumstance.

On the other hand, I have met with cases of incontinence of urine in young people which might be considered as of an *involuntary* or passive nature, and in which the urine flowed off in the night without their being conscious of it. In such cases there seemed to be some peculiar morbid condition of the urinary organs, exceedingly difficult to be overcome, as the affection (which could hardly be referred to an unnatural condition of the urine) has sometimes remained more or less till long after puberty, and even till late in life, in spite of every remedy. This form of the affection, as well indeed as the above, sometimes runs in families, and I have known almost all the children, especially the females, of a large family, more or less subject to it.

Incontinence of urine, in aged individuals, is generally of a very different character from the above, and may depend on a variety of causes, such as various diseases about the neck of the bladder and prostate, general paralysis, partial paralysis produced by injuries of the spine, over distension of the urethra from calculus, &c.

From what has been said of the nature and causes of urinary incontinence, it will be readily seen, that the treatment of this affection will vary very much in different instances. In children, when it is associated with gravel, it is of the utmost importance that this point should be attended to, and the appropriate treatment employed in the first place, for without this, almost all other remedies will be in vain. After the tendency to gravel has been subdued, tonics and particularly sea bathing, &c. may be employed with advantage; and in those instances particularly distinguished by want of power or sensibility in the urinary organs, various stimuli, such as cantharides, either exhibited internally, or in the form of blisters, so as to sensibly affect the neck of the bladder, often produce much advantage. The same, or similar means, may be employed in advanced life, when the nature of the affection is analogous; but when it depends on some organic affection, which is by far most frequently the case, the aid of the surgeon is commonly necessary. In such distressing cases some receptacle or vessel for receiving the urine as fast as it flows away is necessary, and thus the disagreeable consequences arising from this cause is in some degree prevented. The *jugum* *penis* in such cases has been much recommended by some foreign surgeons, and there may be instances in which it may be employed with advantage, but in general, I believe, its use is deprecated in this country, especially in young people, in whom, if the case is properly treated, it can be very seldom necessary.

10. *Pains in the Back and Loins.* Patients often complain of pain and uneasiness about the back and loins, accompanied by various anomalous sensations, which make them apprehensive of the presence of stone, or some worse affection of the kidneys, &c. Many of these sensations are often symptomatic, or of a muscular nature only; others are of so doubtful or anomalous character, that in many instances, it is very difficult to determine what they indicate; and it is with a view of facilitating a discrimination among these various symptoms, that my attention in this paragraph is chiefly directed.

When there is pain in the region of the kidneys, accompanied by symptomatic fever and derangement of the stomach, with scanty, high coloured, and acid urine, there is reason to suspect the presence of inflammatory action either in these glands or their immediate neighbourhood. When in conjunction with the above symptoms the pain extends downward and forward towards the groin and is accompanied by vomiting, retraction of the testicle, and numbness in the thigh on the same side, with pain or tenderness just above the pubes, and bloody urine, there is reason to suspect the presence of a calculus in the kidney or ureter. If the patient has formerly passed lithic acid, or if this appears in the urine at the time of the attack, the calculus is probably composed of that substance. If the patient is in the prime of life; has never passed gravel of any sort; if his general health is good, or at most, if he labours only under some obscure gouty symptoms, or inherits a tendency to that affection, and if the urine be of a yellowish cast, and not remarkably acid, there is reason to suspect that the calculus is of the mulberry variety. If the constitutional irritation be more than usually urgent, the urine pale coloured and alkalescent, or speedily becomes so, and abounds in the phosphates, the calculus will most probably be found to consist of the phosphates chiefly. This latter, however, as well as the cystic oxide renal calculus, are very rare forms of the disease.

When more or less of the above symptoms occur, they generally render the presence of a calculus in the kidney unequivocal; but there is a great variety of anomalous symptoms connected with this subject, which, in the absence frequently of the characteristic symptoms above-mentioned, render it impossible, in many instances, to come to any certain determination on the point: such are a constant sensation of uneasiness, soreness, heat, or chilliness about the back, accompanied by flushes of heat, extending more or less over the whole body, and an apparent rushing of blood to the head, with *tinnitus aurium*, various nervous affections in different parts of the body, as pain and soreness in the epigastric region, along the course of the nerves of the arm, &c. These symptoms are almost always connected with great derangement of the digestive functions, and a very unnatural condition of the urine, and however severe and troublesome they may be, are in many instances merely symptomatic. They occur most frequently in middle aged individuals labouring under hypochondriasis, and in those who have never had gout, but who seem to inherit a disposition to that affection. I have known them also happen very frequently in individuals who have spent a large portion of their life in warm climates, and in such the right side in particular has been most frequently affected: hence the idea that the affection was connected with some hepatic derangement, and mercury has been given freely, but too frequently with very little advantage, and often with decidedly bad effects.

The symptoms above-mentioned are sometimes associated with, or assume the form of a rheumatic or muscular affection; in this case they are apt to be much increased by motion; while on the contrary, in many cases, nothing affords such decided and immediate relief as exercise; in such cases as the latter, one would hardly suspect the presence of a calculus in the kidney, yet I have known this circumstance occur, when, in conjunction with the other symptoms, those of the presence of a calculus seemed unequivocal. I mention this to show how exceedingly difficult it is to form a satisfactory notion of the precise nature of the affection in these cases, and how guarded we should be in our prognosis. I have known such affections continue for many years, in spite of every remedy, and at length terminate (sometimes fatally) by a sudden determination of blood to the head, or some other part, or by an attack of irregular gout. Occasionally they have terminated in the passing of a small mulberry calculus, and in one case, after no less than eleven years of suffering, a case of this description terminated in this manner, and the patient became comparatively well for a time, till another calculus, as was evident from the symptoms, began to form in the kidney.

Of these symptoms, although it is impossible, as before observed, to determine any thing with certainty with regard to the presence or absence of stone in the kidney, yet the fact should be always borne in mind, that they *may* indicate the presence of such an affection, and at any rate they render it very probable, that such a thing *will* happen; more especially when the individual is of a gouty habit, or has suffered from chronic hepatic affections in warm climates, &c. Hence the attention should be particularly directed to this point, and the unnatural state of the urine counteracted as speedily as possible, by the appropriate remedies, and according to the principles laid down in the preceding pages. Great attention also should be paid to the constitutional symptoms, which must be combatted as effectually as possible, by close attention to regimen, and all those remedies, the exhibition of which is too well understood to require to be detailed here.

11. *Irritation and Pain in the Bladder.* It need scarcely be observed, that by irritable bladder, is here meant any state of that organ connected with a frequent desire and pain or difficulty of voiding the urine. An irritable state of the bladder therefore may depend on a great variety of causes, many of which, as well as their *modus operandi,* are sufficiently obvious and intelligible; such, for example, are the presence of a stone, or other foreign body in the bladder; organic diseases of that organ, &c. On these obvious points, which have been already discussed, I shall not dwell here, but shall confine my attention to circumstances of a more doubtful character, and that chiefly with a view to diagnosis and the exhibition of remedies.

When the urine is perfectly natural, both in quantity and quality, and contains no mucous, purulent, or bloody deposite, there is reason to infer that the cause of the irritation is not connected with the urinary system, and must be sought for elsewhere, as in the rectum (or uterine system in females), &c. When the quantity of urine is simply increased, but this secretion is otherwise natural, and contains no mucus, &c., the irritation probably partakes of a spasmodic character, and in females is likely to be connected with hysteria. When the urine is natural, but contains much mucus, the whole inner coat of the bladder is likely to be more or less involved in the affection; when natural urine contains pus or blood, the affection is probably of a more *local* character, as abscess, calculus, &c.

When the urine is unnatural, and more especially when it is *alkaline,* it is evident that the kidneys, and probably the whole system, are implicated in the affection, and it becomes thus of a much more formidable character. Alkaline urine, of itself, is not only liable to cause great irritation in a healthy bladder; but probably cannot continue long without actually producing a chronic disease of its inner coat; and when these two circumstances exist at the same time, the sufferings of the patient are commonly very great,—indeed they constitute one of the most distressing and formidable instances of irritable bladder. In some of these cases it is exceedingly difficult to determine whether the kidney or the bladder be the principal seat of the disease; as in certain renal affections in particular habits, even when the urine is not very unnatural, the pain is confined chiefly to the neck of the bladder; but when the urine is actually diseased, and more especially alkaline, we may be certain, as before observed, that the kidney is *functionally;* and if the patient be of a scrofulous habit, and the case of long standing, very probably *organically* affected, and the prognosis is uniformly much more unfavourable. Attention to these simple rules will sometimes furnish a clue to the nature of the affection, when every thing from the other symptoms alone appears full of obscurity and uncertainty.

Before I close this subject it may be well to remark, that hysteric females often suffer the most excruciating agony in the region of the bladder and urethra, which sometimes assumes all the characters of stone, &c. The state of the urine will, as before observed, generally throw light on this subject, but still reliance should never be placed on this alone, and in all doubtful cases the most careful and rigid examination will be necessary. For it should be always borne in mind, that in irritable habits, and especially in females disposed to hysteria, a *very slight* cause, such as small stone in the bladder, &c. will often produce very great suffering, and that in such cases though the hysteric symptoms predominate, and conceal the original character of the disease, it is nevertheless of a *mixed* character, and will probably cease entirely on the removal of the slight exciting cause.

With respect to the treatment to be adopted in an irritable state of the bladder, this of course will depend on the cause. In all cases, however, the properties of the urine are to be uniformly taken into account; and it should be constantly borne in mind, that in many instances it is much more easy to do a great deal of mischief by injudicious remedies, than it is to do good by any treatment whatever. The exhibition of alkaline and acid remedies will be regulated according to the condition of the urine, and the principles before laid down. With respect to balsamic and other remedies of that character, which have been considered to act specifically in some states of irritable bladder, I can say very little. I prefer the soothing plan in all instances, and whatever increases the pain and irritation seems to me to be calculated to do mischief. That many of the balsamic remedies act in this manner, when given in large doses, there can be no doubt, and in more than one instance I have seen them (turpentine or the *Dutch drops*, for example) when given in this manner, lead to fatal consequences. If they are used it should be with caution, as there are some constitutions and cases that will not bear them in any shape or quantity, while others will bear them apparently with advantage, even in pretty large doses. As a general rule, therefore, it will be best to begin with very small doses (combining them perhaps with sedatives in some instances), and to push them very slowly and carefully; and should they appear to increase the irritation, either to diminish the dose, or, what is better, suspend the use of the remedy for a time. Exhibited in this way they will do no harm at least, and in some cases there is a chance of their doing good.

Tests, Apparatus, &c. required in making Experiments on the Urine.

Perhaps the following list may not be deemed superfluous by some of my readers.

Litmus Paper, blue and *red; Turmeric Paper.* By these all points connected with the acescency and alkalescency of the urine may be determined.

A Watch Glass, or what is better, a *thin platinum vessel* of the same shape, for detecting an excess of urea, evaporation, &c.

Two small Discs of Plate-glass for discriminating pus from mucus, according to Dr. Young's method. They are also useful for other purposes.

A Bottle for determining the specific gravity of the urine; or what is better, a *small portable hydrometer,* made by Tuther, 221, High Holborn, for that purpose, and which is sufficiently accurate for practical use.

A Blow-pipe, Forceps, &c. by which almost every experiment that can be required can be readily made on gravel or calculous matters, so as to lead to a knowledge of their nature.

These, with one or two small test tubes, and small stoppered phials, containing solutions of pure ammonia, potash, and nitric acid, can be readily packed into a small portable case, or pocket-book, and will be sufficient, by the aid of a common taper or candle, to perform all the experiments on the urine, and urinary productions, that are commonly necessary in a practical point of view.

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